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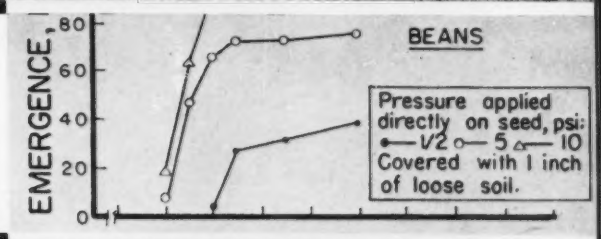

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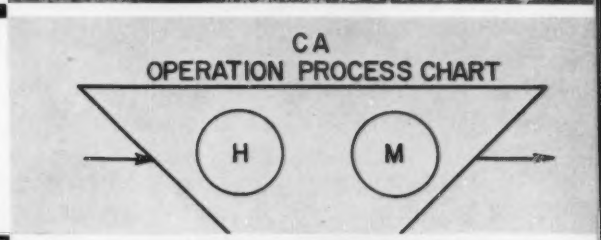

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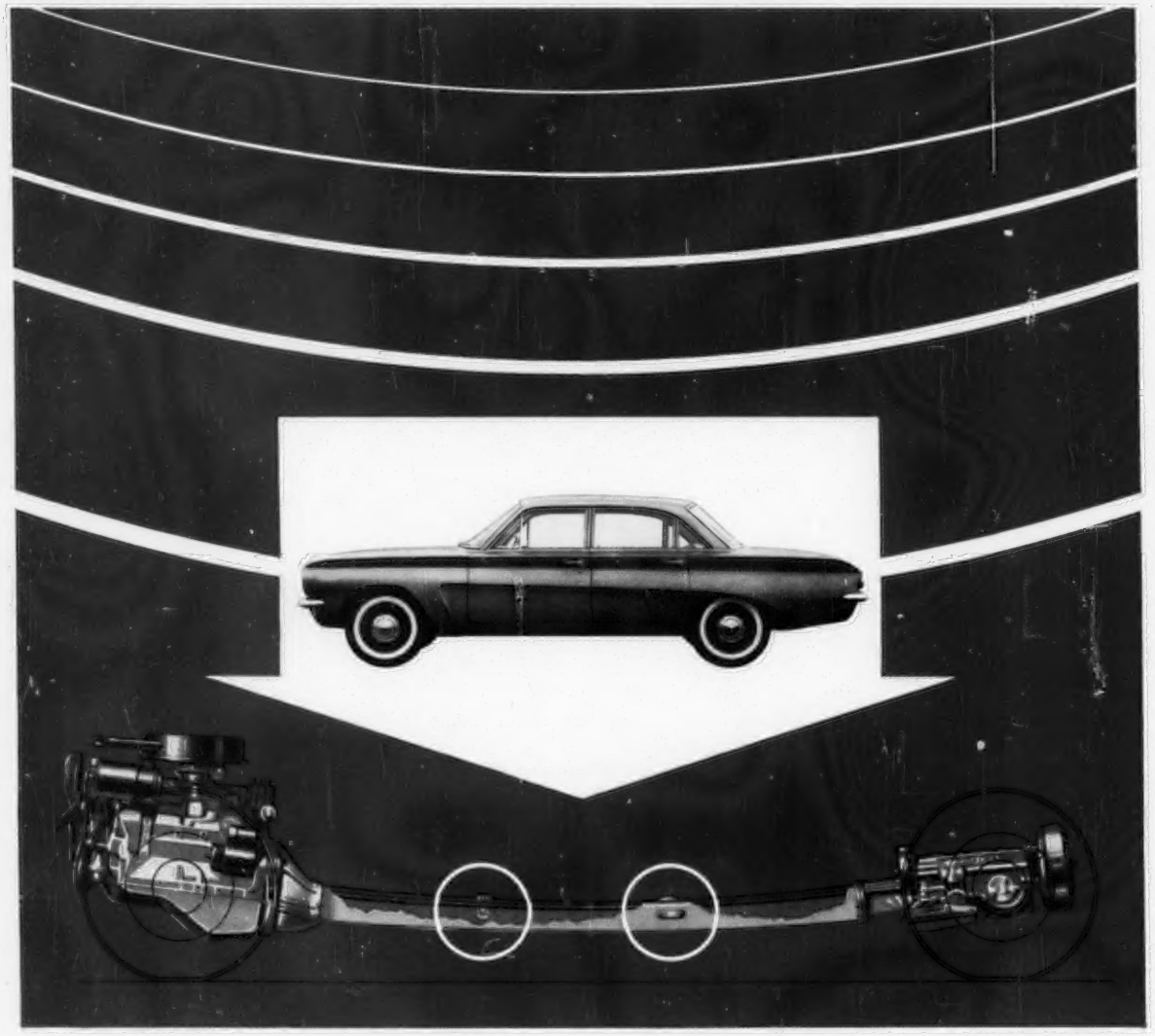
NEW DEPARTURE CASE HISTORY



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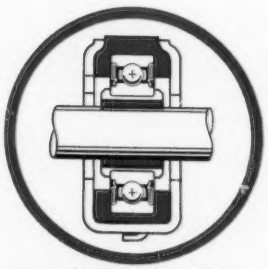

Two N/D ball bearing assemblies like this are mounted within "bent" torque tube.

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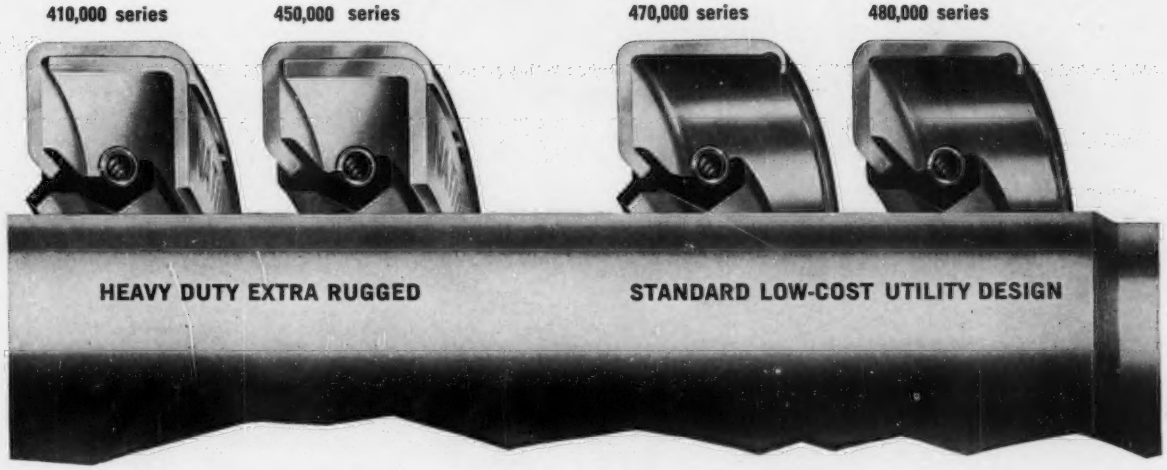

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Agricultural Engineering

Established 1920

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ASAE Participates in Paris Meeting

ON March 2 through 7, 1961, the International Technical Congress of Agricultural Machinery (CITMA) will be held in Paris, France. The Congress, the first of its kind, is held in such high regard that all details are handled under direct supervision of the Prime Minister of the French Republic Government and a committee composed of ministers of agriculture or industry, representing major manufacturing countries of agricultural machinery. A board of honor has been set up consisting of ministers of agriculture from countries undergoing development and directors or chairmen of national or international associations concerned with agricultural mechanization.

R. C. HAY
Appointed ASAE Honorary Vice-President

The entire program generates around the general theme, "The contribution of agricultural machinery to the advancement of human conditions and more particularly to the assistance of countries which are undergoing development." This theme contributes to the "Freedom from Hunger Campaign," led by the Food and Agriculture Organization of the United Nations (FAO) which actually will participate in the work of the Congress.

The technical program will consist of five sessions, of one-half day each, in which agricultural engineering personalities from all countries have been invited to comment on papers which can be written in one of the following four languages: English, French, German, and Russian. All papers will be printed for circulation to participants before the meeting. Comments by the author on the main points of his paper and the following debates will be translated simultaneously into the four selected languages. Subjects discussed will be as follows:

1. General human and social problems, especially those concerning training, arising from the mechanization of agriculture in insufficiently equipped countries which are undergoing development;

2. Technical means of reclaiming land in these countries, in the areas of clearing, irrigation, and soil preparation and conservation;

3. Methods used in these countries for cultivating special crops (cereals, rice, cotton, peanuts) and experiments carried out in these countries on agricultural machinery;

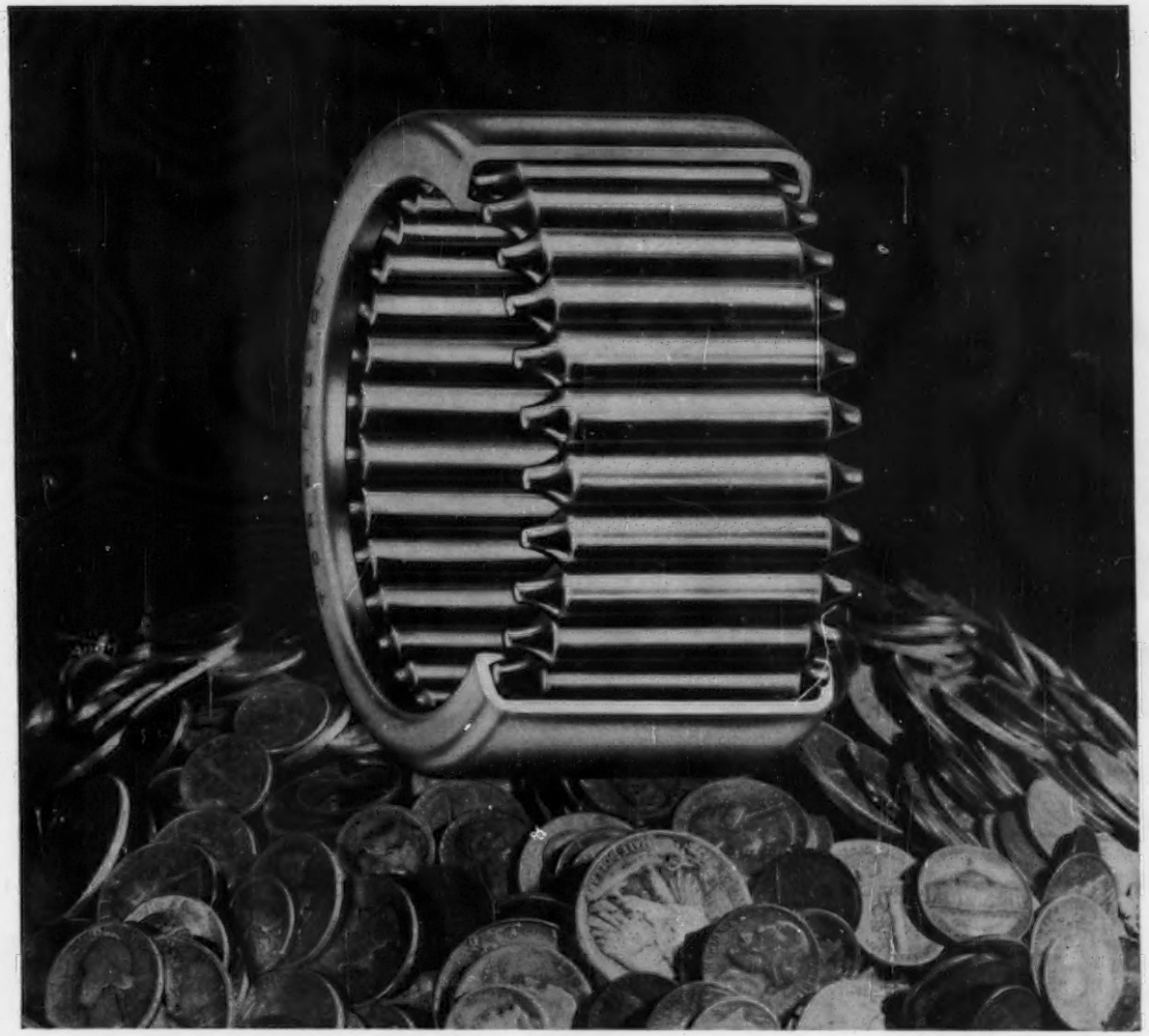
4. Economic and financial problems arising from mechanization in insufficiently equipped countries under development.

Advance reports indicate that two papers will be presented by ASAE members from United States. A. W. Farrall, head of agricultural engineering, Michigan State University, and nominee for president-elect of ASAE, will present a paper entitled "Advanced Training in Agricultural Engineering for World Agriculture." P. W. Manson and E. R. Allred of the University of Minnesota, and R. C. Hay of the University of Illinois have prepared a paper entitled "Increased Crop Production Through Improved Irrigation, Drainage and Soil-Erosion Control Practices." R. C. Hay will attend and make the presentation.

For the occasion, and in the interest of displaying sincere interest and cooperation in the meeting, the Council of ASAE, during its Winter Meeting in Memphis, December 4 to 7, 1960, named R. C. Hay as honorary vice-president of ASAE to serve as an official representative along with A. W. Farrall, who will represent Michigan State University, ASEE and also ASAE.

Further details may be obtained by writing to Monsieur G. Sarradon, president, or Monsieur A. Thibon, secretary, CITMA, 19, Rue Jacques-Bingen, Paris, 17, France.

Following the meeting the annual Paris Farm Machinery Show will be held March 7 to 12. See page 94 for details.



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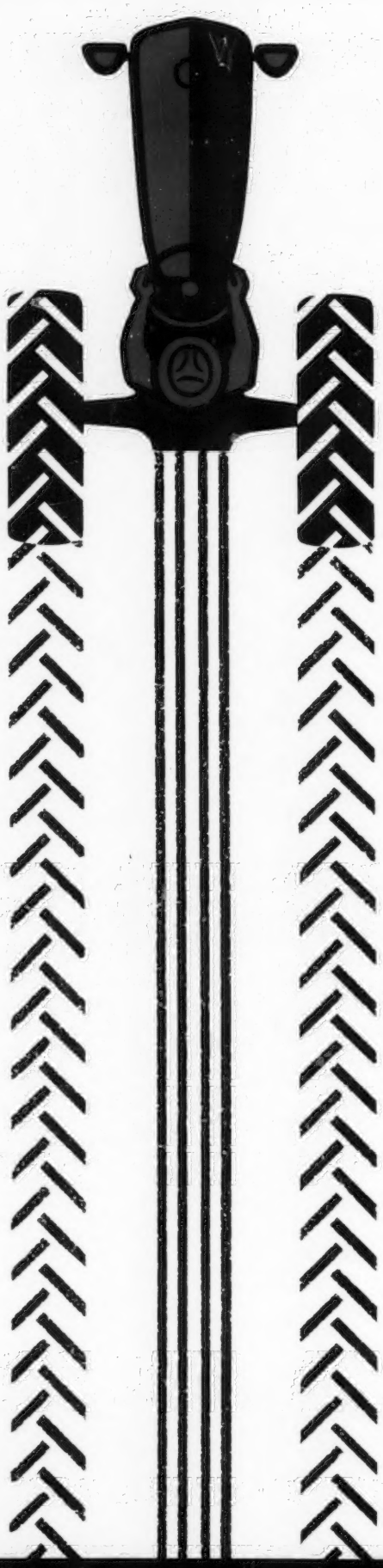

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Bendix design actually increases torque capacity, while reducing brake size, and provides maximum lining area in minimum space. Also steps up efficiency through fast heat dissipation.

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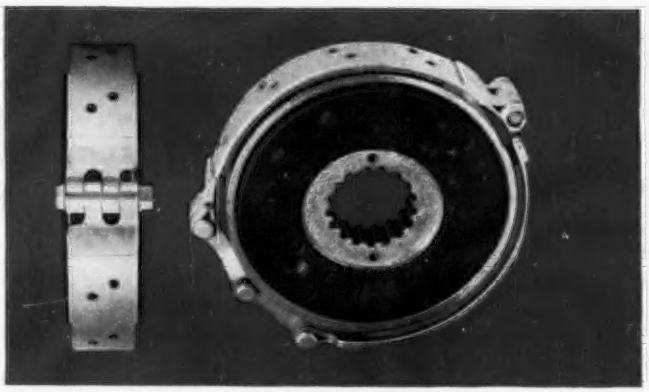

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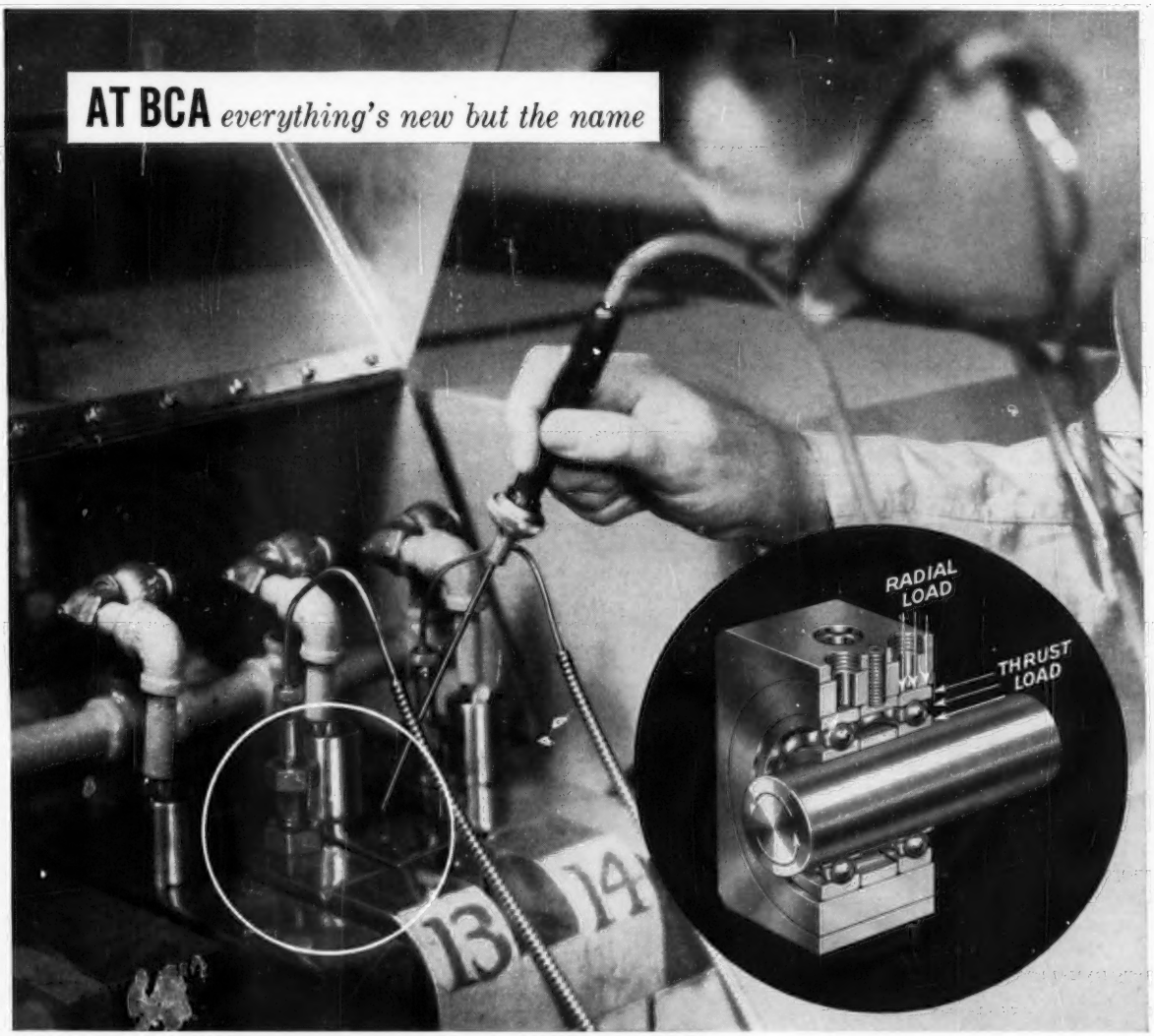

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These machines and BCA's other unusual testing devices are designed and built to help us develop the highest quality ball bearings available. By simulating actual operating conditions, BCA ball bearings can be tested to *exceed* customer specifications.

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Idea factory is an investment in tomorrow's agriculture

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Here nearly 1,500 men . . . engineers, soils experts, chemists, metallurgists, even atomic scientists . . . look ahead to the needs of tomorrow's farmer. These men know farming and farm needs. The most modern laboratories and facilities in the farm equipment industry are at their disposal. Design, development, and testing of farm equipment go on twenty-four hours each day.

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Building farm tractors and equipment best fitted to the farmer's needs has made IH first in farm equipment. And the greatest research and development program in the industry will put tomorrow's IH farm equipment even farther ahead.

World's biggest farm equipment research center puts 10 acres of tomorrow under one roof. Here, design, development, and testing of farm equipment are carried on by skilled teams, using the most up-to-date equipment and instruments.

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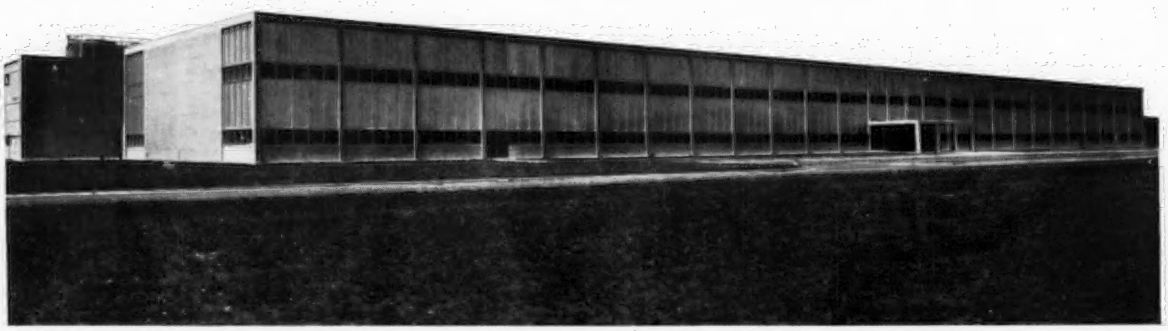

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JOHN DEERE 14T Baler conveys and compacts the windrowed hay into the baling chamber with a Link-Belt screw conveyor.

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The New Holland "Compact Hayliner 65" is powered by Neapco 1800 Series Safety Shielded Assembly.

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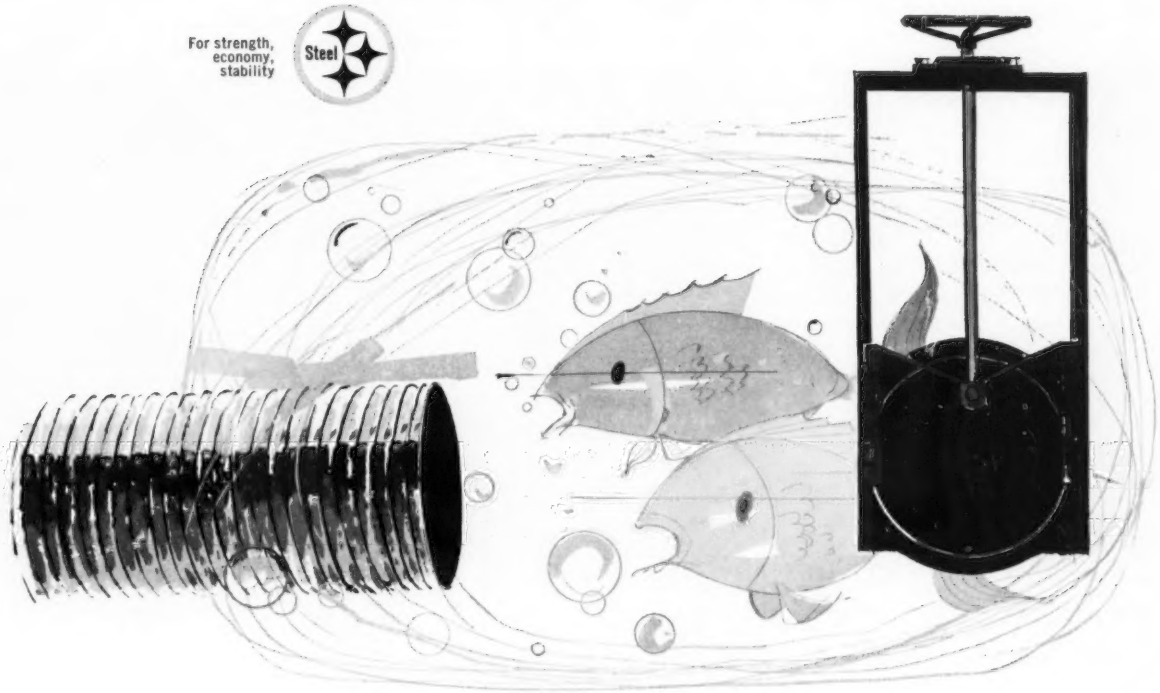

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Regardless of pond size or soil condition, Armco can supply every farm pond component you need. Here are the products, each made from economical, durable steel:

Armco Corrugated Steel Pipe is ideal for spillways. Watertight coupling bands assure a perfect waterseal. Perforated Pipe serves as toe drainage. *Armco Corrugated Steel Sheets* give your pond anti-seep protection around the spillway, and—as baffle plates—stop whirlpool action at the inlet. Steel interlocking sheets, in the foundation of the dam, guard against water seepage. And *Armco Slide Gates* help control water level.

All products in Armco's farm pond "package" have been proved by long service in a multitude of uses. To see how they fit *your* needs, just send the coupon. An Armco Sales Engineer will provide necessary technical data without cost or obligation.

New steels are born at Armco

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Report to Readers . . .

MECHANIZED FARM FENCE BUILDING MAKES DEBUT

Elsewhere in this issue is a report made to an ASAE meeting, by an industry agricultural engineer, of the development of a fence-erecting machine that completely mechanizes the building of wire fencing. Construction of this machine utilizes components already in production, and it is designed for use with standard farm tractors commonly equipped. . . . . The machine will handle most types of fencing, including woven wire, multiple strands of barbed wire, or a combination thereof and steel or wood posts, as well as corners and end assemblies. Moreover, it is designed to erect both posts and fencing in a single operation, that is, at one pass. . . . . Limited tests indicate that, with this equipment, it should be reasonable to expect a three-man crew to erect a mile of fence per day. Or, stated in another way, it should be possible to build fence two or three times faster than by manual erection.

JET INJECTION OF AMMONIA INTO THE SOIL SURFACE

Illinois AES agricultural engineers are reported to be conducting a research study of the possibility of direct injection of ammonia into the soil. For this purpose a high-pressure jet of liquid ammonia is discharged just above the surface of the soil. The energy produced by the jet carries the ammonia into the soil, where the liquid quickly evaporates and is distributed through the soil as a vapor. Success of this development would mean replacement by jets of the knives and furrow openers used in conventional ammonia applicators.

ENGINEERS DEVELOP MACHINES TO PLANT . HARVEST TOBACCO

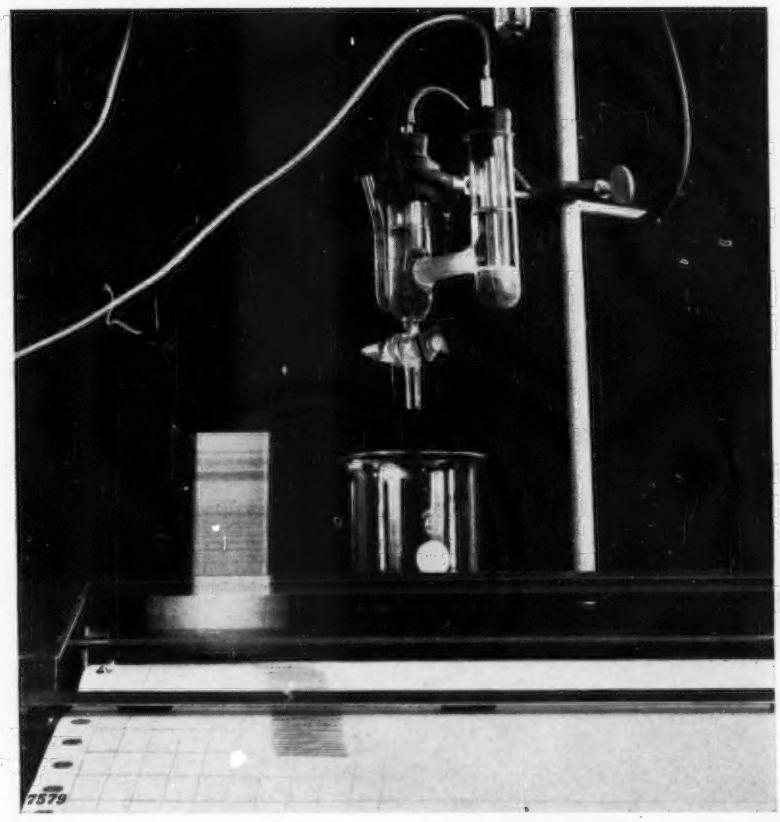
Kentucky AES agricultural engineers now have under development two items of equipment that may well prove a great boon to tobacco growers. One of these is a machine to plant pelleted seed; the other machine harvests the stalks of the tobacco plant. . . . . The new planter will enable growers to plant pelleted seed directly in the field, thereby eliminating the present labor-consuming, plant-bed system. (It is estimated that enough seed to plant an acre can be pelleted at a cost of 50 to 60 cents.) . . . . The capacity of the experimental harvester is equivalent to that of six men performing the harvesting job by hand, and it requires only one man for its operation. It is a more complex machine than the planter, since it must have a stalk cutter and be designed to spear the cut stalks and carry them, without bruising or tearing, through the machine, and then deposit them in a safe place for housing. . . . . The engineers believe that, with this harvester, one man can operate it and harvest by himself about three acres of tobacco per day.

PROGRESS IN MECHANICAL HARVESTING OF CHERRIES

Extensive tests during the past two crop seasons have convinced Cornell agricultural engineers that the harvesting or red tart cherries can be mechanized. They found that mechanical harvesting was equal to hand picking both in respect to fruit quality and percent harvested. Their studies are being continued in order to improve both equipment and techniques. . . . . Gentle shaking of tree limbs to prevent excessive damage to fruit was found unnecessary. Increasing frequency of the shake appeared to reduce the amount of bruising and attached stems. High-frequency, short-stroke operation tended to be more effective in removing fruit from the tree than a low-frequency, long stroke. The former also appeared to reduce danger of bark damage, especially in the case of young trees. . . . . The engineers believe changes in tree structure are inevitable for practical adaptation of large, tractor-mounted shaker units. Also, it is desirable, for efficient operation, that the orchard floor be reasonably smooth and free of tall weeds, stones and ruts. Changes appear necessary, also, in such cultural practices as tree spacing and pruning and in processing procedures such as trash and stem removal.

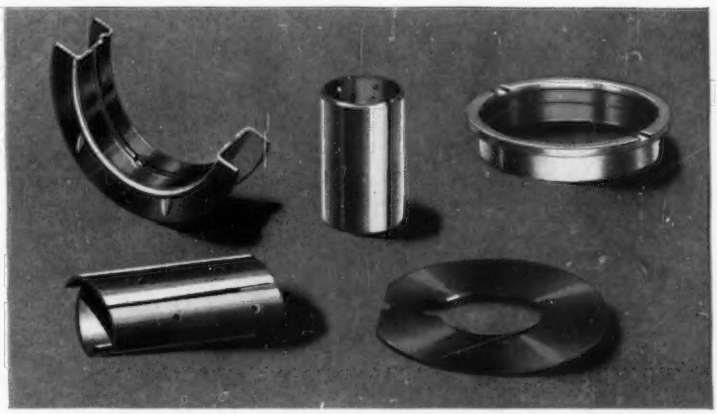
(Continued on page 60)

ANALYTIC "BLOODHOUND" SNIFFS OUT SECRETS OF BEARING CORROSION



WE USE THIS HYPERSENSITIVE DEVICE TO TRACK DOWN ENGINE BEARING CORROSION TO ITS SOURCE. This instrument needs only a minute fragment of metal for accurate analysis. Consequently, engine bearing corrosion can be traced from its beginning through complete destruction of the bearing surface. Because test variables are minimized, Federal-Mogul engineers can accurately relate degree of corrosion to specific engine operating conditions. This analytical tool is in continual use in our laboratory, assisting research on many different projects. Prevention of corrosion and development of new bearing alloys are high on the list!

SUCCESSFUL BEARING PERFORMANCE depends on selecting the proper alloy for the operating conditions to be met. Federal-Mogul engineers have had years of experience with bearings and applications of all kinds . . . and this wealth of knowledge is available to bearings users. This is one reason why F-M sleeve bearings, precision thrust washers, formed bushings, and low-cost spacers are chosen for use in virtually everything from baby buggies to heavy industrial cranes.



There's much valuable data in our Design Guides on sleeve bearings, thrust washers and bushings; and in our brochure on spacers. For your copies, write Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc., 11081 Shoemaker, Detroit 13, Michigan.

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sleeve bearings
bushings-spacers
thrust washers

DIVISION OF
FEDERAL-MOGUL-BOWER
BEARINGS, INC.

. . . Report to Readers (Continued from page 58)

BUTCH HAIRCUT IDEA APPLIED TO MECHANIZED PEACH TREE PRUNING

A California county farm advisor, one of the first to adapt mechanized "hedgerow" pruning (an accepted practice for citrus) to deciduous fruit trees, reports that tests over a three-year period have shown that mechanized winter pruning cuts costs from $20 to $30 an acre. In one peach orchard, a large tractor-mounted saw sliced through a heavy growth of twigs and branches, leaving behind a mat of prunings up to four inches thick, with the tops of the trees trimmed as smoothly as a butch haircut. . . . . This practice has not only saved pruning costs but it has gained two advantages: (1) The severe pruning by the hedgerow method has in many cases improved the subsequent crop, and (2) slicing off the lush vertical growth, which shoots up from the top of the tree each season, has resulted in far more bearing fruit wood lower down on the trees where the crop is easier to handle. . . . . Field studies thus far have not indicated what the ultimate method of mechanical pruning may be, but the extension specialists are convinced that "hedgerow" pruning will cut costs and not hurt the crop. The ultimate technique may also include what appears a drastic new approach: summertime mowing of lush topgrowth. Experiments with summertime mowing of tree tops, both before and after harvest, have indicated that fruit size is not affected and that fruit wood growth in the lower part of the tree is substantially encouraged.

RESEARCH INDICATES LIMITS FOR PLACING OF STARTER FERTILIZER

Of particular interest to agricultural engineers are the results of recent tests at the Iowa State University soil-testing laboratory on the proper placement of starter fertilizer for corn. Though it is frequently recommended that this fertilizer be placed 2 inches to the side and 2 inches below seed level, according to the Iowa tests this may be too deep to increase growth of corn plants the first few weeks following emergence. . . . . The corn root system, two weeks after emergence, is made up mainly of roots that develop from the kernel. So if corn plants are to benefit from "starter" fertilizer during that period, they should be placed in bands to the side and not more than one inch below seed level.

BASIS OF DETERMINING DEPTHS FOR DRAINTILE

A California AES irrigation engineer points out that present drainage theories were developed for homogeneous isotropic soils which are seldom, if ever, encountered in the field. The most general soil, he says, is one in which the hydraulic conductivity decreases with depth due either to layering or to natural development. . . . . This engineer goes on further to point out that the drainage of such soils is being investigated by means of the electrical analog. Several typical soil profiles have been analyzed. Flow patterns have been determined and the rate of water-table drawdown indicated. In such soils the proper depth for tile drains is clearly shown by the analysis.

PLASTIC BUBBLES PROVE USEFUL AS TEMPORARY FARM STRUCTURES

Not only simple and useful but also inexpensive, says a Michigan AES agricultural engineer, apropos of plastic bubbles (polyethylene film) as temporary structures for farm use. These "bubble buildings" are usually made of 6-mil film. They are held firm and made airtight by placing the outer edges of the film in a trench 12 to 18 inches deep and refilling it with earth. . . . . Bubble buildings are inflated in the same manner as a balloon, and air pressure is maintained by a small electric motor and fan. Inside pressure is only about 3 lb. per square foot above atmospheric pressure. . . . . An advantage of this type of building is that it can readily be moved and stored when not in use. Its cost is around 20 to 25 cents per square foot of floor space. . . . . The use of clear polyethylene film for buildings has the disadvantage of excessive heat inside in summer sunlight. Also the film tends to become brittle and break in direct summer sunlight, but it remains firm and pliable in either cool or cold weather.

FARM-MADE CEMENT MIXER SAVES TIME & HARD WORK

Lloyd Stauffer, whose farm is near Greene, Iowa, needed a very small cement mixer for pointing up concrete around the barn. So, he built the one shown here. His materials consisted of an old Texaco Universal Gear Lubricant drum, pipe and angle iron for the frame, and bearings from a junk pile. Aside from the ¼-horsepower motor, the whole job cost less than $5.

To lubricate their cement mixer and other equipment, Lloyd (left), and his father, Vic, use Texaco Products supplied by Texaco Distributor Darrell Davis (right). These progressive farmers prefer Marfak lubricant. They know that Marfak forms a tough collar around open bearings. It won't drip out, wash out, dry out or cake up.

The motorized field equipment used by this father-and-son combination includes two tractors and a truck. The Stauffers have used Texaco Products for more than five years. They know *it pays to farm with Texaco Products.*

FIRE CHIEF FOR HIM!

H. Lee Cherry (right) farms 350 acres in the rich tobacco area near Washington, North Carolina. Here he is getting a delivery of Texaco Fire Chief gasoline from Texaco Distributor H. G. Winfield. Lee prefers Fire Chief because it delivers superior fire-power and draw-bar pull for low-cost operation. The reason is that economical Fire Chief is Climate-Controlled for altitude and seasonal temperatures. He, too, knows that *it pays to farm with Texaco Products.*

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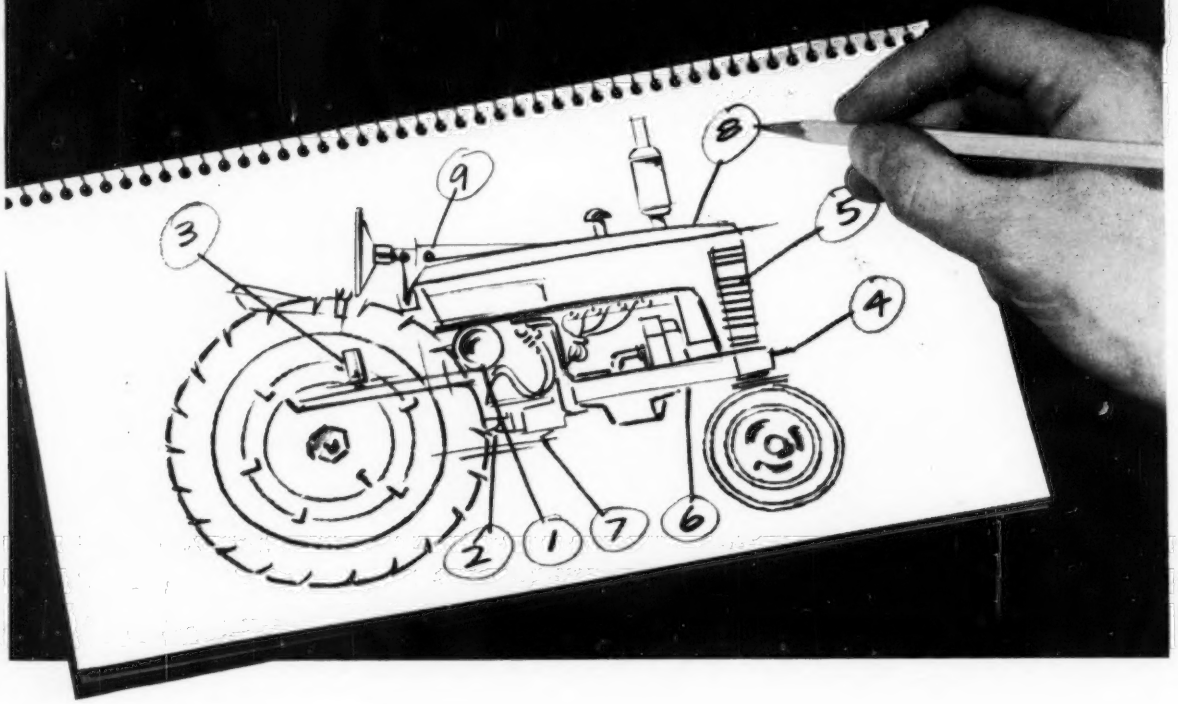
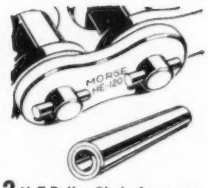


First—check these Morse power transmission components to solve many design problems!

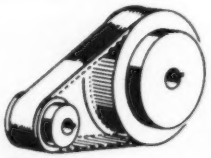
1 Taper-lock sprockets on side power-take-off shaft



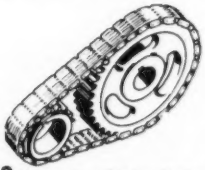
2 H-E Roller Chain for power transmission

3 Morse torque limiter on power-take-off shaft

4 Morflex coupling on front-end drive shaft take-off

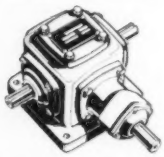


5 Timing® Belt drives for fuel injection application

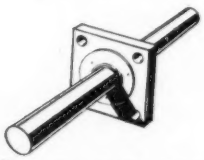


6 Morse silent Timing Chains for tractor engines

7 Hy-Vo® Drives for drop-box transmission



8 Miter boxes for pto drives for saws or grinding wheels



9 Two-Way, No-Way Clutch for hand throttles

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BEARING BRIEFINGS

ROLLER GUIDANCE– VITAL FACTOR IN BEARING LIFE

Roller guidance has been established by the Anti-Friction Bearing Manufacturers Association as a major rating factor for roller bearings. There is a direct relationship between this factor and the life and capacity of a cylindrical roller bearing under load.

Figure 1 illustrates the results of a loose fit between a roller and the guiding ribs of the raceway. Because of lack of guidance by the ribs, the roller is free to skew and skid under load. Such a condition invariably leads to early bearing failure.

To achieve close roller fit and proper roller guidance, Bower precision grinds each bearing race on specially designed centerless grinders. In this operation, Bower positions the integral raceway ribs *from the theoretical centerline of the bearing*. This method produces bearings with high dimensional accuracy and perfect symmetry.

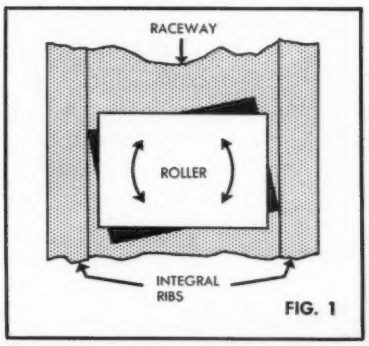
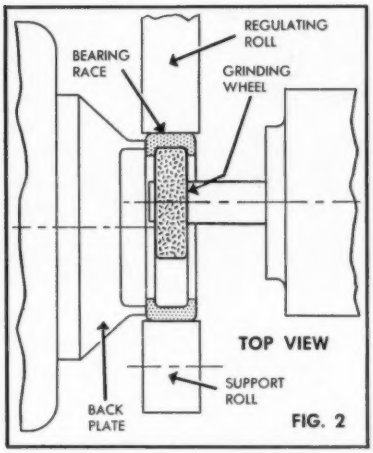
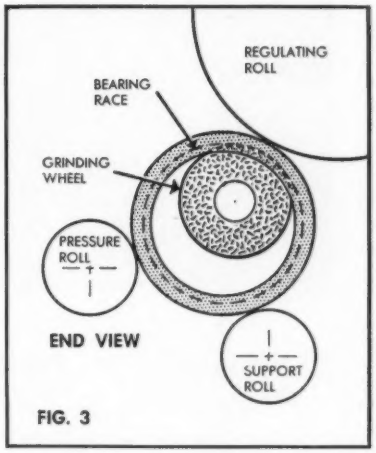


Fig. 1. Loose fit in raceway means poor roller guidance. Roller can skew and skid under load.

In addition, the close tolerances held in grinding the roller track and integral guiding ribs give Bower cylindrical roller bearings the ability to *take thrust in any direction*. A Bower cylindrical roller bearing has thrust capacity of from 10-15% of its rated radial capacity!



Figures 2 and 3 diagram the centerless grinding method used to finish Bower raceways. Use of this technique assures not only optimum roller guidance and maximum bearing life, but also virtually eliminates bearing runout. BEARING SYMMETRY WHICH RESULTS FROM THIS TECHNIQUE PERMITS ACCURATE SHAFT LOCATION REGARDLESS OF HOW THE OUTER RACE AND ROLLER ASSEMBLY ARE INSTALLED. IT COMPLETELY ELIMINATES THE POSSIBILITY OF IMPROPER INSTALLATION.



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Whatever your bearing needs, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.

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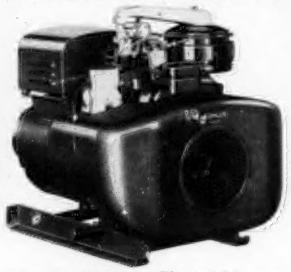

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Agricultural Engineering

February 1961
Number 2
Volume 42

James Basselman, *Editor*

ASAE Council Announces Agricultural Engineering Exposition

L. W. HURLBUT
ASAE President

B. T. VIRTUE
ASAE President-Elect

OF extraordinary interest to the agricultural engineering profession is the announcement, made jointly by ASAE President L. W. Hurlbut and ASAE President-Elect B. T. Virtue, that the Council of the Society has officially approved the holding of an ASAE-endorsed Agricultural Engineering Exposition of manufactured products. This Exposition or show is to be held in conjunction with the Society's next regular winter meeting scheduled for December 12 to 15, 1961, at the Palmer House in Chicago.

This Exposition is the first one of its kind ever to be endorsed by the ASAE. The event will be devoted primarily to the display and demonstration of materials and equipment components. Their range of type and kind is forecast as including new, standard, or improved products judged to be of interest to agricultural engineers in all branches of their profession. The engineers believed to be particularly benefitted by these displays and demonstrations are those responsible for research, product development, design and specification in agricultural engineering industries.

The jointly-prepared statement by ASAE President Hurlbut and B. T. Virtue, the man who will succeed him as president in June 1961, included the following important considerations:

"The educational-industrial Exposition provides for each member a positive opportunity to update himself on the newest developments in components, products and applications. It provides a missing link — the link between progress in design and development of components — and the application in advanced product engineering.

"Besides making attendance at the meeting more valuable to you, the Exposition will be attractive to visitors. And, visitors are prospective members.

"There are also some important values to be gained through prestige-building contacts with manufacturers and other technical activities closely associated with ASAE. Through news announcements, letters, promotional leaflets, and by word-of-mouth, the Agricultural Engineering Exposition should be a real help in attracting more attention to our Society and its important activities. So, the Exposition opens a new line of communication with more engineers and with more production and management personnel.

"The Exposition should be of intense interest to engineering educators, extension workers, and the student agricultural engineers who will soon join our ranks. It will provide invigorating motivation for more advanced learning and teaching."

The Agricultural Engineering Exposition will occupy the Exhibit Hall at the Palmer House. It is readily accessible from the areas where meetings of ASAE will be held. Considerable study was given to the preparation of the Exposition schedule and hours when doors would be open to those registered at the Winter Meeting. It is important that registrants have ample time to visit the Exposition, and to attend and participate in the technical program sessions. To minimize any potential confusion, the Agricultural Engineering Exposition will be open one day prior to the beginning of the technical program sessions and will close the day before the technical meetings end.

To further avoid conflicts between show hours and technical sessions, it has been arranged to have the programs presented each day, Wednesday, Thursday and Friday, between 8:00 a.m. and 3:00 p.m. The hours for the Agricultural Engineering Exposition will then be from 2:00 to 9:00 p.m. on Tuesday, Wednesday and Thursday.

The Agricultural Engineering Exposition, it is believed, will provide development, design and research engineers working in the field of agriculture with an excellent and unusual opportunity to inspect and obtain firsthand, authoritative information concerning a wide variety of components, equipment and materials to assist in the solution of problems confronting them. This combined with the usual program of technical papers and discussions of the ASAE winter meeting dealing with subjects of timely interest, will add substantially to the value of these meetings to agricultural engineers.

Management of the Exposition at Chicago will be the responsibility of Shea Expositions Corp., of Pittsburgh, which has had wide experience in managing trade shows. After thorough investigation, ASAE officers are confident that the Shea organization is eminently qualified to render the Society competent and reliable service in the promotion and operation of the ASAE-endorsed Agricultural Engineering Exposition.

ASAE has appointed two special Exposition committees—the Committee on Exhibit Policy and Management — and, the Booster Committee. Both of these committees will help to plan the Exposition in accordance with the best interests of the Society and its individual members.

Those interested in making arrangements for exhibit space may contact Agricultural Engineering Exposition, c/o Shea Expositions Corp., One Gateway Center, Pittsburgh 22, Pa.

Development of a Fence Erecting Machine

S. S. DeForest
Member ASAE

Post driver, hoist, and dispensing and stretching equipment combined in one operating unit

HISTORICALLY, fence building is an arduous, time consuming, uninteresting, costly, but necessary chore on livestock farms. Although there are many devices that will do part of a fence-building job and eliminate some of the labor, there was no known equipment that would do the complete fence-building job which our company believed was necessary. It was felt that a machine for this purpose should have the following minimum requirements:

1. It should be based on or built around adaptable equipment already in production
2. It should operate over most of the usual types of farm land
3. It should handle most of the types of fencing, including woven wire, multiple strands of barbed wire, a combination of these and steel or wood posts and corners and end assemblies
4. It should erect posts and fence in a single operation
5. It should erect fence on an existing line of posts
6. It should stretch barbed and woven wire simultaneously
7. It should be designed for use with regular farm tractors, commonly equipped
8. It should carry a reasonable supply of line posts and corner or end assemblies
9. It should not damage or deform fence materials
10. It should be safe to use and demonstrate.

To meet these minimum requirements, our company developed and tested a fence erection machine that possessed the following components:

Post Driver. Posts are driven with a commercially available PTO operated driver modified to operate with the left hand and a special mounting. It mounts on any tractor equipped with a three-point hitch and can be plumbed with hydraulic cylinders. The mounting allows it to be moved laterally, without affecting its plumb position, so the driver can be placed easily over the point where the post is to be driven. Moving the tractor forward or backward places the driver over the correct point along the fence row.

Platforms. Two independently suspended platforms are semimounted to each side of the post driver on a horizontal hitch in such a way that a driven post may pass between as the tractor moves forward. The rear ends are supported by caster wheels and the front end hinged so the platforms are flexible in the vertical plane and rigid in the horizontal. They carry a supply of posts and wire and support the dispensing and stretching equipment.

Dispensing Equipment. Woven wire is unreeled on a removable vertical spindle which, when in place on the machine, is locked to a brake mechanism to apply slight tension to the wire as it is dispensed. The spindle is removable for insertion into a new roll of wire.

Barbed wire is dispensed from spool holders which are kept from turning freely by a multiple-disk brake to which they are linked by a chain drive. Each spool holder is attached to a separate disk so that alternate disks operate against each other as the barbed wire is dispensed, regardless of the number of spools being used. The brake is an effective tension equalizer.

Special pulleys are used to handle the barbed wire so the barbs are not damaged as the wire is dispensed.

Stretching Equipment. Woven wire, after it leaves the spindle, passes through a self-adjusting, hydraulically operated clamp which is operated to hold the wire from further unreeling. Moving the tractor and machine forward stretches the wire.

Barbed wire cannot be stretched in the clamp simultaneously with woven wire because the woven wire, being equipped with tension curves, can be stretched more without breaking. When stretching short distances, the barbed wire by-passes the clamp and the multiple-disk brake is used for maintaining constant tension. For longer distances and when barbed wire alone is used, all strands may be run through the clamp and stretched simultaneously.

Hoist. A hydraulically operated hoist is used to lift woven wire rolls into place on the machine. The spindle is removed from the machine, inserted into the roll of wire and the combination lifted with a cable.

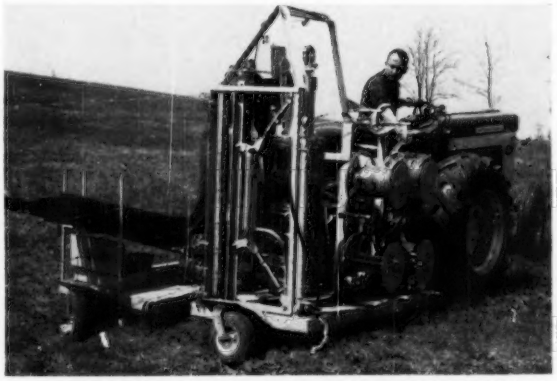

Fig. 1 Hydraulic cylinders of this fence-building machine plumb the post driver, hoist rolls of woven wire into place, and operate the clamp for holding wire while it is being stretched. The equipment mounts on any tractor with power take-off and three-point hitch

Paper presented at the Annual Meeting of the American Society of Agricultural Engineers at Columbus, Ohio, June 1960, on a program arranged by the Farm Structures Division.

The author — S. S. DeForest — is industry representative, market development div., United States Steel Corp., Pittsburgh, Pa.

Supply Transport. About fifty steel line posts and four or five steel corner and/or end-post assemblies may be carried with the machine.

Operation of the Machine

In operation the fence-erecting machine is best handled by three men, one driving the tractor, one operating the post driver and one carting supplies. The third man may be eliminated but operational speed will be sacrificed.

The first step in building fence with this equipment is to have a reasonably clear right-of-way. Although the machine will go through trees, up and down or around hills, and across depressions wherever the tractor can go, building fence by machine is easier (like building fence by hand) if the proper preparation is made.

The next step in the building operation is to lay out the fence row. This may be done in two ways: either by stretching a guide line which may be barbed wire and used later as the bottom wire of the fence, or by marking each post location with a short stake or spot on the ground.

One-pass Operation. If one-pass operation is desired, the tractor and unit are positioned to drive the end or corner assembly. This being done, the unit is moved ahead, straddling the fence row. After the fence wires are attached to the end-post assembly the unit is moved along, unreeling wire and stopping periodically so posts may be driven at predetermined locations. Every three to ten posts, depending on the ground cover and terrain, the clamp is used to hold the woven wire from further unreeling and the desired tension put in the fence by moving the tractor forward. If barbed wire is also being used, it by-passes the clamp and tension is automatically held by the multiple-disk brake.

The wires are then attached to the line posts and the entire operation repeated until the next end, corner or line brace assembly is reached.

Two-pass Operation. Terrain or other conditions may be such that it is desirable to detach the two platforms and use the driver alone to drive posts in one pass. Then in a second pass, after remounting the platform with the wire supply on the left side of the hitch (right side is normal for one-pass operation), the wire is dispensed at the edge of the path of the tractor as the tractor drives adjacent to the posts.

The stretching and wire-attaching operations are the same as in the one-pass operation.

Fig. 3 Up to four strands of barbed wire may be handled at one time by this fence-building machine. Tension of each strand is controlled by a tension equalizer doubling as a safety clutch

Problems and How They Were Handled

Ends and corner assemblies were developed to make maximum use of the efficiencies of mechanical fence erection. Results through one winter with an experimental design are good even where single spans were used for fence stretched more than one-half mile. There was no heaving of the corner posts. Care was used, however, in not stretching the fence too tightly because, as the work done by the agricultural engineering department at Michigan State University indicates, it is pointless to stretch a fence tightly initially, when its tension relaxes the next season.

Also, by stretching the fence often instead of once every 20 or 40 rods, a more uniform tension results.

To fasten the fence to the corner assembly, a clamp arrangement is used eliminating the need for wrapping the wire.

Gates can be attached easily to hardware using prepunched holes in the posts. *(Continued on page 88)*

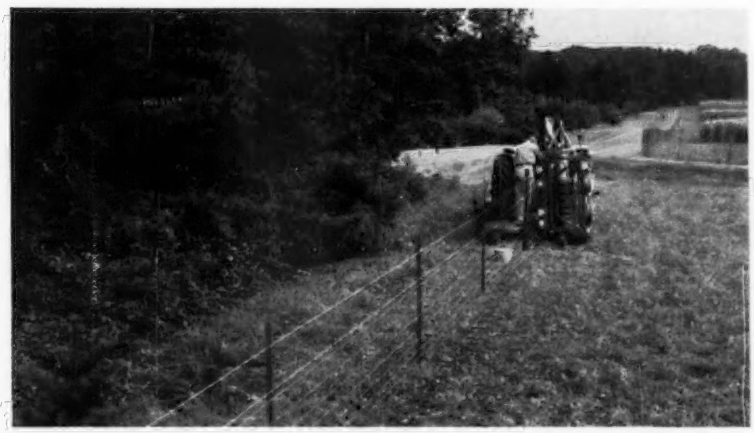

Fig. 2 Erecting fence in a one-pass operation by driving posts, dispensing woven and barbed-wire fencing, and stretching the fence to proper tension for attaching to posts

EFFECT OF Soil Compaction ON SEEDLING EMERGENCE UNDER SIMULATED FIELD CONDITIONS

B. A. Stout, W. F. Buchele and F. W. Snyder
Member ASAE *Member ASAE*

TO design a machine suitable for precision planting of sugar beets, corn, beans or other field crops, it is necessary to have accurate information on the functional requirements of the machine. Although a great deal of research has been conducted to improve planter performance, the environment required by the seed to produce a healthy seedling has not been defined in precise terms that can be used by the engineer in designing a planter. Many of the factors affecting the emergence of seedlings are not easily controlled by the planter. Soil compaction, however, may be controlled by mechanical devices such as press wheels on the planter; therefore, its influence on seedling emergence under varying conditions is of primary interest.

Packing the soil may affect the emerging seedling by altering *(a)* the availability of moisture, *(b)* the availability of oxygen, and *(c)* the mechanical resistance of the soil to penetration by the seedling.

Moisture

The need for moisture during germination and emergence has long been recognized and the specific requirements of many species have been determined. Hunter and Erickson (9)* found that the minimum seed moisture content for germination was approximately 30 percent (wet basis) for corn, 50 percent for soybeans and 31 percent for segmented sugar beet seedballs. They found that the maximum soil-moisture tension for germination was 12.5 atmospheres for corn, 6.6 atmospheres for soybeans and 3.5 atmospheres for sugar beets. Hanks and Thorp (6, 7) reported that the ultimate seedling emergence of wheat, grain sorghum and soybeans was approximately the same when the soil moisture content was maintained between field capacity and permanent wilting percentage, if other factors were optimum for seedling emergence. The rate of emergence, however, was related directly to the soil moisture content.

Cook *et al* (2) stated that seeds should be planted in a firm, well-packed seedbed because, in firm soil, water moves quickly into the seed. They reasoned that water would move up to the seedling until the roots move down into moist soil. Jamison (10) pointed out, however, that a very compact soil may impede moisture movement and reduce the moisture supply available to a plant. Stout (14) found that surface pressures in excess of ½ psi did not increase the final moisture content of sugar beet seedballs. Also, the seedballs absorbed water more rapidly when submerged in water than when planted in moist soil. Stout concluded that the rate of moisture absorption by sugar beet seedballs was limited by factors external to the seedball, such as the rate of capillary flow through the soil, rather than flow into the seedball itself. Thus seedbed preparation and planting practices should promote maximum capillary flow of water to the seed. Hunter (8) soaked sugar beet seedballs in water for 4 hours prior to planting to wet the seed faster, but found little benefit in a field test. Dexter and Miyamoto (3) reported that coating the surface of sugar beet seedballs with hydrophilic colloids (gelatin, agar and "algin") accelerated water uptake from sand and hastened emergence from soil under field conditions.

Aeration

Farnsworth (4) found that soils with an air capacity of less than 12 percent suppressed germination of sugar beet seeds due to the poor aeration. Hanks and Thorp (6) observed that oxygen was a limiting factor in the emergence of wheat seedlings whenever the oxygen diffusion rate was below 75 to 100×10^{-8} grams per square centimeter per minute. This rate of diffusion corresponded to a pore space of approximately 16 percent in a silty clay loam and 25 percent in a fine sandy loam. Morinaga (11) found that beans, corn and many other seeds would not germinate under water, although they germinated well on moist blotters. Failure to germinate under water was attributed to a lack of oxygen. Lettuce, celery and other seeds germinated satisfactorily under water. It is apparent that oxygen is necessary for germination and that the minimum requirement is not the same for all crops.

Mechanical Resistance of the Soil

The influence of the physical condition of the soil on emergence of seedlings is commonly recognized, but little quantitative work has been reported. Carnes (1) concluded that the soil should be packed below the seed in order to give the seedling a firm footing for penetrating surface crusts. Richards (13) found that an increase in crust strength from 108 to 273 millibars† resulted in a decrease in emergence of bean seedlings from 100 to 0 percent. Hanks and Thorp (6, 7) reported that crusts apparently limited emergence of wheat, grain sorghum and soybeans,

Paper presented at the Annual Meeting of the American Society of Agricultural Engineers at Ohio State University, Columbus, Ohio, June 1960, on a program arranged by the Power and Machinery Division.

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Authors' Note: This paper reports the results of cooperative investigations of the Michigan Agricultural Experiment Station and the Crops Research Division, ARS, USDA, and is based on a Ph.D. thesis by B. A. Stout, entitled "The Effect of Physical Factors on Emergence of Sugar Beet Seedlings." It is approved for publication as Journal Article 2604, Michigan Agricultural Experiment Station.

*Numbers in parentheses refer to the appended references.

†A unit of pressure, 1000 dynes per square centimeter or 0.0145 lb per square inch.

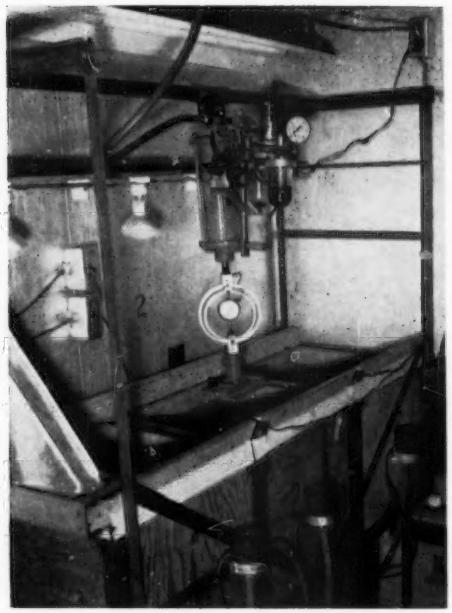

Fig. 1 *(Left)* Apparatus used for studying the effect of soil compaction on emergence of seedlings in soil boxes 16 in. deep

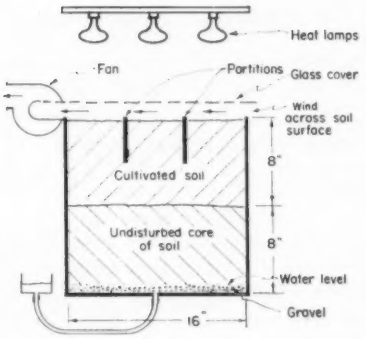

Fig. 2 *(Right)* Schematic drawing of soil box and apparatus

especially at the lower soil moisture contents. At a constant moisture content, seedling emergence decreased with increasing crust strength, although some seedlings emerged even where the crust strength was as high as 1400 millibars.

Morton (12) constructed a soil penetrometer to measure the force required for emergence by pushing a probe upward through the soil. From the force and distance moved, the energy expended in pushing the probe through the soil was determined.

Previous laboratory and field results (14, 15) have indicated that excessive compaction of the soil at the surface may impede emergence of sugar beet seedlings. Surface pressures ranging from ½ to 5 psi have consistently induced better emergence than higher pressures.

The purpose of this study was to determine the effect of soil compaction on emergence of sugar beet, corn and bean seedlings under controlled laboratory conditions in which water was supplied below the seed and allowed to move upward by capillarity.

Experimental Procedure and Results

Three boxes of the type shown in Figs. 1 and 2 were constructed. Cores of undisturbed Sims subsoil were placed on a layer of gravel in the bottom of the boxes and sealed along the edges with agar. A layer of Sims sandy clay loam‡ topsoil was placed above the cores and divided into three compartments by removable vertical partitions. Provisions were made for adding water to the soil at the bottom to maintain upward capillary flow through the soil. The experiments were conducted in a constant-temperature chamber in which air temperature was maintained at 60 F. The chamber was equipped with a fan and duct system to move air across the top of the boxes at a velocity of 5 mph, simulating a wind blowing across a field. Heat lamps were placed above the soil surface to provide radiant heat.

‡Physical properties: 47 percent sand, 28 percent silt, 25 percent clay; ⅓ atmosphere tension equals 24.3 percent dry basis; 15 atmosphere tension equals 12.8 percent dry basis.

The soil was compacted by means of the hydraulic cylinder (5) and the force ring shown in Fig. 1. Pressures of ½, 5 and 10 psi were applied to the soil in the various compartments. Each box constituted a replication. Corn, bean and sugar beet seeds were treated with a fungicide, planted and then covered to a depth of 1 in. Soil-moisture samples were taken from each compartment at the beginning and end of each experiment. In some cases, bulk density cores were also removed. Emergence counts were made daily. At the completion of each experiment, the partitions were removed from the boxes and the soil was thoroughly mixed to a depth of 4 or 5 in. Several days elapsed between tests for the soil moisture content to approach equilibrium. A summary of the conditions for the five experiments is given in Table 1.

Experiment 1. Pressures were applied to the soil surface after planting. No water was added during the experiment, since the soil contained ample moisture for emergence. Under these conditions, packing the soil with a pressure in excess of ½ psi reduced emergence (Fig. 3). Poor emergence in the compartment receiving 10 psi apparently was due to the inability of the seedlings to penetrate the compacted soil. To give an indication of variability in this

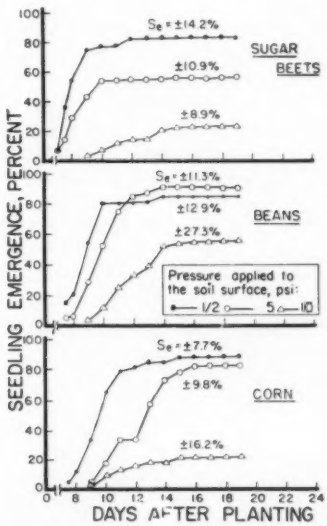

Fig. 3 Accumulative emergence for Experiment 1, in which no water was added after planting

experiment, the standard error of estimate was calculated for each of the curves and is presented in Fig. 3.

Experiment 2. The soil moisture content at planting time was less than for Experiment 1 (Table 1). The procedure was the same as for Experiment 1, except that seven days after planting the water level was raised to the top of the soil cores, 8 in. below the soil surface. Within a few days the soil in the compartments which received pressures of 5 and 10 psi appeared moist on the surface while that which was packed with ½ psi remained dry. The emergence patterns were entirely different from those of Experiment 1. The higher pressures induced more rapid emergence than the ½ psi pressure, but after 20 days there was little difference in total number of seedlings (Fig. 4).

The results of Experiment 1 indicated that excessive pressure on the soil surface was undesirable because the seedlings were unable to penetrate the packed soil. Under dry soil conditions (Experiment 2), however, a certain amount of soil compaction was desirable when there was a supply of moisture below the seed level. In order to take advantage of any beneficial effects of packing the soil and yet not impede the emerging seedling, it seemed logical to apply pressure to the soil at the seed level and then cover the seeds with loose soil. This was tried in Experiment 3.

Experiment 3. Pressures of ½, 5 and 10 psi were applied at the seed level, pressing the seeds firmly into the soil. All seeds were covered with 1 in. of loose soil. The most rapid and highest percentage of emergence occurred in the compartments receiving the highest pressure (Fig. 5). Emergence was poor in the compartments receiving only ½ psi. These results have a great deal of practical significance. They indicate that better stands can be obtained by pressing the seed firmly into the soil, but leaving the soil over the seed loose so that it will offer a minimum of resistance to the emerging seedling. Nearly every commercial planter now being used employs press wheels which compact the soil at the surface.

Experiment 4. A 1-in. layer of soil was removed, the seeds were placed on the moist soil and a pressure of 5 psi was applied to the soil in all nine compartments, pressing the seeds firmly into the soil. Then the seeds were covered with 1 in. of loose soil, and pressures of ½, 5 and 10 psi were applied to the soil surface. Water was added to each box of soil through the inlet at the bottom. The results indicate no appreciable benefit from surface pressures above

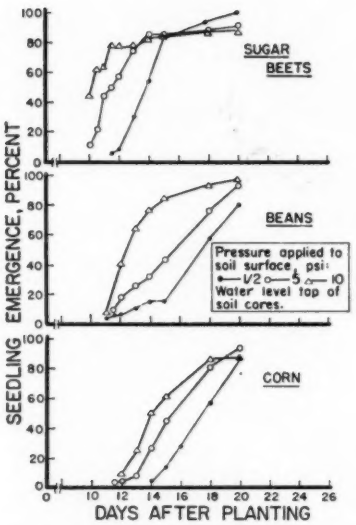

Fig. 4. Accumulative emergence for Experiment 2, in which the soil moisture at planting was insufficient for rapid emergence

½ psi, until the sixteenth day after planting (Fig. 6). Sugar beet emergence was 2 to 3 days earlier when only ½ psi was applied to the surface as compared with pressures of 5 or 10 psi. The total emergence of sugar beets and corn was somewhat higher as a result of the ½ psi treatment, while emergence of beans was higher as a result of the 10 psi treatment. Because total emergence was not reached until approximately three weeks after planting, only limited practical significance is attached to it. The effects of surface pressures were less than for experiments in which no pressure was applied at the seed level.

Experiment 5. After planting and packing the soil with surface pressures of ½, 5 and 10 psi, water was sprayed on the soil surface simulating a ½-in. rain. Severe crusting developed. Then several simulated "rains" were applied in an effort to keep the soil surface moist and permit the seedlings to penetrate the crust. On the tenth day after planting, no seedlings had emerged, and it became apparent that the crust would have to be broken so that the seedlings could emerge. The results (Fig. 7) obtained after breaking the crust indicated that ½ psi was more favorable than the heavier pressures for emergence of sugar beet seedlings, but little can be concluded about the effects of soil compaction

TABLE 1. SUMMARY OF CONDITIONS FOR EXPERIMENTS 1 THROUGH 5

Soil type: Sims sandy clay loam
Number of replications: 3
Variety of seed: Corn — Michigan 480 hybrid
Beans — Michelite
Sugar beets — US 400 whole seedballs
Pressure: ½, 5, 10 psi
Aggregate size: Natural field soil through a ¼-in. screen
Depth of planting: 1 in. before packing; approximately 15/16, ¾, ½ in. after packing.
Wind velocity: 5 mph

Experiment No.	Soil moisture content at seed level, percent		Water added to soil after planting	Method of applying pressure
	Initial	Final		
1	19	18.0	None	At the soil surface
2	17	16.3	Water level 8 in. below surface	At the soil surface
3	18	17.0	None	At the seed level, covered with 1 in. of loose soil
4	15	20.2	Water level 15 in. below surface	5 psi at seed level in all compartments; ½, 5, 10 psi on the surface
5	—	17.2	Simulated rain: 1⅛ in. of water added to surface after packing	At the soil surface

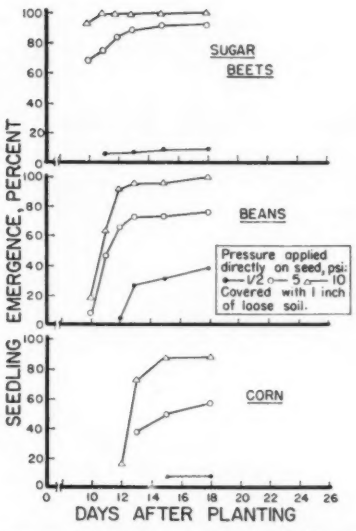

Fig. 5 Accumulative emergence for Experiment 3, in which no water was added after planting

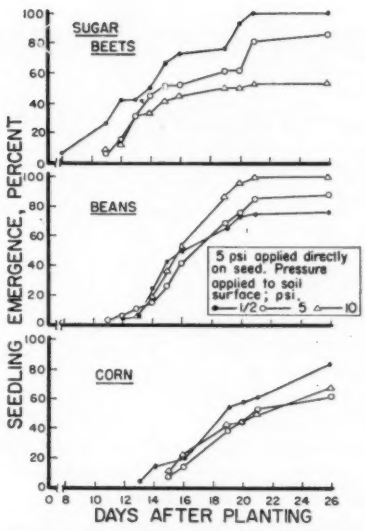

Fig. 6 Accumulative emergence for Experiment 4, in which water was added at the bottom of each box

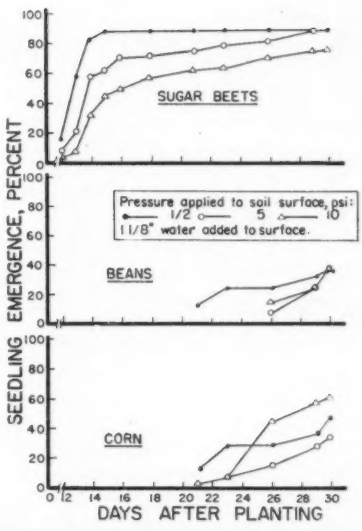

Fig. 7 Accumulative emergence for Experiment 5, in which water was sprayed on the surface simulating rains

on bean or corn seedlings because no emergence occurred until three weeks after planting. At the end of Experiment 5, bulk density cores were removed. The average bulk densities were 0.96, 1.01 and 1.08 grams per cubic centimeter in the compartments receiving ½, 5 and 10 psi, respectively.

Discussion

The effect of soil compaction on emergence of seedlings under simulated field conditions varied with the soil moisture content and the point of application of the pressure. When the soil moisture was adequate for emergence (Experiment 1), the most rapid emergence (80 percent in 9 to 11 days) resulted from a surface pressure of ½ psi while higher pressures (5 or 10 psi) suppressed emergence. This may have been due to *(a)* poor aeration, *(b)* the inability of the seedling to penetrate the compacted soil, or *(c)* a combination of these.

When the soil moisture was near the minimum required for emergence and lacked a supply of moisture from below the seed level, packing the soil with surface pressures up to 10 psi did not improve emergence (14). In Experiment 2, however, when a supply of capillary moisture was available below the seed, a surface pressure of 10 psi induced faster emergence than a pressure of ½ psi. The final emergence was about the same irrespective of the pressure applied. These results indicate that packing the soil will improve emergence only when adequate moisture is available below the seed.

Since packing the soil at the surface adversely affected seedling emergence under certain conditions, another method of packing the soil was needed. By packing the soil at the seed level and covering the seed with loose soil, the adverse effects of surface compaction were minimized. Packing at the seed level actually enhanced rapid emergence. Hudspeth and Jones (7a) have reported that pressing cotton seed into the soil by means of a narrow presswheel hastened emergence and improved the stand.

Conclusions

1 Evidence obtained in the laboratory indicates that planters for sugar beets, corn and beans should be designed to *(a)* pack the soil below the seed level, *(b)* press the seeds into the compacted soil, and *(c)* cover the seeds with loose soil.

2 The moisture content of the soil greatly influences the effect of soil compaction on seedling emergence. Packing the soil at seed level may improve seedling emergence if adequate moisture is available below the seed. If moisture is not available below the seed, packing at any level is of no benefit.

Summary

Laboratory experiments were conducted to determine the effect of compaction on emergence of seedlings from Sims sandy clay loam at various moisture contents. Field conditions were simulated by placing an 8-in. layer of undisturbed subsoil in a box and covering it with an 8-in. layer of tilled top soil. Water was added to each box at the bottom, 16 in. below the surface. Heat lamps were placed above the soil surface and a 5-mph wind was simulated by drawing air across the soil surface. The air temperature was maintained at 60 F. Emergence of sugar beet, bean and corn seedlings was observed after the soil was compacted at the surface or at the seed level.

Under the conditions employed in this laboratory study, pressures in excess of ½ psi applied at the surface usually suppressed emergence of seedlings. Pressures of 5 and 10 psi applied at seed level, however, improved emergence. These results indicate that planters should be designed to apply the higher pressures to the soil at seed level, but should place relatively loose soil above the seed.

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2 Cook, R. L., McColly, H. F., Robertson, L. S., and Hansen, C. M. (1958) Minimum tillage, Michigan State University, Ext. Bul. 352.

(Continued on page 87)

Minimum Tillage for Corn:

Its Effect on Infiltration and Erosion

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Member ASAE

The practice of minimum tillage and subsequent cultivations are scrutinized in terms of soil and water losses

MINIMUM tillage has recently gained popularity as a farming practice. Acceptance of this reduced tillage practice has been largely based on decreased cost of operation, although various other desirable features have been advanced. One of the claimed advantages, soil and water conservation, has been based more upon observation and an examination of the resulting physical conditions than on controlled field research. To obtain research information on the soil and water conservation characteristics of minimum tillage, a five-year study was initiated near Lafayette, Ind., in 1959. Plots with conventional tillage and various types of minimum tillage were established for study with simulated storms produced by the rainulator, a field-plot rainfall simulator (8, 9)*. Subsequent cultivations as compared to no cultivation were also included in the study. This paper reports the results for the initial year of this research.

BACKGROUND

Various methods of minimum tillage for row crops have been proposed. Each is based upon one or more particular advantages such as less cost for adapting equipment, fewer trips across the field, and a better resulting seedbed (3). A study of soil and water losses from runoff plots with conventional and plow-plant tillage was reported by Free (6). However, conclusive results were not obtained due to lack of sufficient and properly timed rainstorms. Free stressed the need for studies with simulated rainfall to obtain the desired comparisons. A progress report by Harrold (7) shows very favorable soil and water conservation results for plow-plant tillage as compared to conventional tillage. The treatments were on different watersheds of variable conditions each year, and the study has not been conducted for sufficient time to obtain conclusive results. Unpublished results at the LaCrosse, Wis., soil conservation experiment station, obtained through private correspondence, show greatly reduced runoff and erosion from wheel-track planting.

Various investigators have studied the influence of soil surface conditions on infiltration. Neal (11) and Borst and Woodburn (2) found that infiltration was greatly increased and soil loss was reduced by cultivation of a crusted soil surface. Duley (4) reported an increase in infiltration rate from 0.25 to 1.6 iph (inches per hour) resulting from the removal of 0.3 in. of crusted surface soil. Musgrave and Free (10) found that soil porosity was the dominant factor affecting infiltration. They reported that the increased pore space of the soil surface resulting from cultivation increased the infiltration greatly and that this effect decreased rapidly with continuing rainfall. These studies indicate that increased infiltration results from soils which are in a loose condition and are free from surface crusts.

Paper presented at the Annual Meeting of the American Society of Agricultural Engineers in Columbus, Ohio, June 1960, on a program arranged by the Soil and Water Division, as a contribution from the Soil and Water Conservation Research Division (ARS), USDA, in cooperation with the Purdue Agricultural Experiment Station, Journal Series Paper No. 1607.

The authors — L. D. MEYER and J. V. MANNERING — are, respectively, agricultural engineer and soil scientist, USDA, Lafayette, Ind.

*Numbers in parentheses refer to the appended references.

Fig. 1 Minimum tillage equipment: *(Left)* plow-plant without smoothing; *(right)* wheel-track planting

PROCEDURE

The six tillage treatments which were selected for comparison are:

(a) Conventional (plow, two diskings with trailing harrow, plant); two cultivations
(b) Plow-plant without smoothing; no cultivation
(c) Plow-plant with smoothing; no cultivation
(d) Plow-plant with smoothing; two cultivations
(e) Plow without smoothing, wheel-track planting; no cultivation
(f) Plow without smoothing, wheel-track planting; two cultivations.

The equipment used for applying the minimum-tillage treatments is shown in Fig. 1. A harrow behind the plow was used as the smoothing tool for treatments (c) and (d). Runoff plots were located on a Russell silt loam soil with 4½ to 5 percent slope and moderate erosion. This is a highly productive grey-brown podzolic soil with a tendency to crust when unprotected by vegetation. The plot area was covered by a vigorous growth of second-year alfalfa and orchard grass prior to tillage. Two replications of the six treatments were applied in a randomized block design. Tillage was performed and corn rows were planted parallel to the slope. Each plot was 35 ft long and 10 ft (3 corn rows) wide with 7-ft borders between plots. The conventional plots were plowed in early May. They were planted and all other treatments were applied the last week in May.

A series of rainulator runs were made during each of three cropping periods: *(a)* shortly after planting, *(b)* after the first cultivation, and *(c)* after harvest. Each series of runs consisted of a 60-min "dry" run at the existing soil moisture condition, a 30-min "wet" run the next day, and a 30-min "very wet" run beginning 15 min after the end of the wet run. The intensity of application for all runs was approximately 2.6 iph. All six treatments of a replication were studied within a few hours by running the first three treatments simultaneously, moving a few rainulator components, and then running the other three treatments. Natural rainfall at the plot site was very low throughout the summer.

EXPERIMENTAL DATA

No evidence of important differences between the various minimum tillage methods was found in this initial year of study. However, important differences were found between the conventional and minimum tillage treatments and between the cultivated and uncultivated treatments. Therefore, the five minimum tillage treatments were combined into groups of similar conditions for comparison with the conventional tillage treatment in this report. Prior to cultivation, the groups are: *(a)* conventional tillage (1 treatment) and *(b)* minimum tillage (5 treatments). Following the first cultivation, the groups are: *(a)* conventional tillage, cultivated (1 treatment), *(b)* minimum tillage, cultivated (2 treatments), and *(c)* minimum tillage, uncultivated (3 treatments). All reported values are averages for the treatments involved.

The runoff and soil losses from each rainulator run were adjusted from the actual application intensity of each individual plot to an intensity of 2.60 iph. The adjustments were based on the assumptions that the infiltration rate was not affected by the slight difference between the actual and adjusted application intensity and that the actual and adjusted soil losses were similarly proportional to their respective erosion indices (15). Infiltration curves are not included. However, the total amount of infiltration during each run and rate at the end of each run are reported. Significance levels of 1 and 5 percent (5) for differences between treatment means are also reported.

The data from each series of runs of the described study are reported separately. Some of the more important research information obtained during each series is also discussed in conjunction with the pertinent data.

Series A (Shortly after planting)

The first series of rainulator runs was conducted two to three weeks after planting. The corn plants were less than one foot tall. The soil surface was dry and somewhat crusted from a rain at planting, and the soil profile was of medium to high moisture content. Representative plots are shown in Fig. 2.

The total amount of infiltration, average infiltration rate during the last five minutes, and soil loss for each run are given in Table 1. The amount and rate of infiltration were much higher for the minimum tillage treatments than for the conventional treatment during all runs. This is attributed to the less compact, more rough, and more open condition of the relatively undisturbed furrow slices of the minimum tillage treatments. Of the 5.2 in. applied during the three runs, infiltration totaled 2.2 in. for the conventional treatment and 3.3 in. for the minimum tillage treatments. Therefore, runoff was 3.0 and 1.9 in., respectively.

The soil loss from the conventional treatment during the series A runs was approximately twice the average soil loss from the minimum tillage treatments. All treatments followed a uniform meadow, and the runs were made shortly after application of the treatments. Therefore, the difference

Fig. 2 Representative plots prior to first series of rainulator runs: *(Left)* minimum tillage (plow-plant); *(right)* conventional tillage

TABLE 1. INFILTRATION AND SOIL LOSS SHORTLY AFTER PLANTING
Series A, June, 1959

Intensity — 2.60 in. per hr, Plots — 35 x 10 ft, Soil — Russell silt loam, Slope — 4½-5 percent

Treatment	Soil moisture prior to run, 0-5 in. depth, percent by weight	Water applied, in.	Total infiltration, in.	Level of significant difference, percent	Final infiltration rate*, in./hr	Soil loss, T/A	Level of significant difference, percent
Dry run (60 min)							
Conventional tillage	17.6	2.60	1.28	1	1.10	7.58	1
Minimum tillage	18.4	2.60	1.95		1.63	3.25	
Wet run (30 min)							
Conventional tillage	26.5	1.30	0.51	1	0.96	4.45	1
Minimum tillage	24.6	1.30	0.76		1.34	2.42	
Very wet run (30 min)							
Conventional tillage	—	1.30	0.44	5	0.86	4.63	1
Minimum tillage	—	1.30	0.63		1.19	2.98	

*Average rate during last five minutes of application

in soil loss was largely due to the greater amount and rate of runoff from the more compact conventional treatment rather than more permanent structural changes of the soil due to the different treatments. Total soil loss for the three runs was 16.7 tons per acre from conventional tillage and 8.7 tons per acre from minimum tillage. The relative difference of soil loss and infiltration decreased with successive runs due to added soil wetting and compaction by the successive simulated storms.

Series B (After first cultivation)

Following the first series of rainulator runs, the conventional treatment and two of the minimum tillage treatments were cultivated with a sweep-type cultivator. The other three treatments were not disturbed. After the cultivation, a second series of runs was made on plots as shown in Fig. 3. Corn height was approximately two feet. The soil moisture was very similar to the content prior to the first series of runs.

The infiltration and soil loss of the series B runs are given in Table 2. Infiltration was greatly increased by the cultivation. This operation eliminated the surface crust which had formed from the intense simulated rainstorms. The soil surface of the uncultivated treatments was severely crusted. The results also show that the infiltration of the cultivated minimum tillage treatments was consistently greater than the infiltration of the conventional tillage treatment which included cultivation. Infiltration rates decreased more rapidly with successive runs for the cultivated treatments due to the formation of a crust and the higher soil moisture content as compared to the uncultivated treatments which already had a severe crust. After the dry run, the infiltration rate of the conventional treatment was similar to the rate of the uncultivated minimum tillage treatments. Total infiltration for the three runs was: Conventional, cultivated, 2.8 in.; minimum tillage, cultivated, 3.4 in., and minimum tillage, uncultivated, 2.3 in. Runoff was 2.4, 1.8, and 2.9 in., respectively.

Soil loss differences for the treatments during the second series of runs were primarily related to runoff differences and differences in erodibility between the crusted and cultivated soils. During the dry run, the much lower soil loss

Fig. 3 Representative plots prior to second series of runs: *(Left)* cultivated; *(right)* uncultivated

TABLE 2. INFILTRATION AND SOIL LOSS AFTER FIRST CULTIVATION

Series B, June, 1959

Intensity — 2.60 in. per hr, Plots — 35 x 10 ft, Soil — Russell silt loam, Slope — 4½-5 percent

Treatment	Soil moisture prior to run, 0-5 in. depth, percent by weight	Water applied, in.	Total infiltration, in.	Level of significant difference, percent	Final infiltration rate*, in./hr	Soil loss, T/A	Level of significant difference, percent
Dry run (60 min)							
Conventional tillage, cultivated	17.6	2.60	1.91	5	1.36	2.44	5
Minimum tillage, cultivated	19.5	2.60	2.17	1	1.61	1.41	1
Minimum tillage, uncultivated	16.9	2.60	1.28		0.99	6.72	
Wet run (30 min)							
Conventional tillage, cultivated	25.1	1.30	0.54	5	0.88	3.39	
Minimum tillage, cultivated	25.7	1.30	0.70	5	1.21	2.13	5
Minimum tillage, uncultivated	23.7	1.30	0.55		0.90	3.90	
Very wet run (30 min)							
Conventional tillage, cultivated	—	1.30	0.39	5	0.74	4.57	
Minimum tillage, cultivated	—	1.30	0.54		1.04	3.02	
Minimum tillage, uncultivated	—	1.30	0.45		0.80	4.30	

*Average rate during last five minutes of application

from the cultivated treatments is largely attributed to the lower amount and rate of runoff. However, the wet run shows possible evidence of higher erodibility for the crusted treatments. For all runs, the soil losses from the cultivated minimum tillage treatments were consistently less than the losses from the cultivated conventional tillage treatment. Soil losses from the three runs during series B totaled: Conventional, cultivated, 10.4 tons per acre; minimum tillage, cultivated, 6.6 tons per acre, and minimum tillage, uncultivated, 14.9 tons per acre.

As during the runs of Series A, relative differences between treatments decreased with successive runs, with the exception of the relation between the soil loss of the conventional and cultivated minimum tillage treatments. For these treatments, the difference increased with successive runs indicating a higher rate of physical deterioration for the soil of the conventional treatment.

Series C (After harvest)

A third series of runs was made in September following harvest. The cornstalks were broken over approximately one foot above the soil surface to simulate the condition left by a mechanical picker. These runs were made approximately four months after planting and 2½ months after the second

(Continued on page 86)

TABLE 3. INFILTRATION AND SOIL LOSS AFTER HARVEST

Series C, September, 1959

Intensity — 2.60 in. per hr, Plots — 35 x 10 ft, Soil — Russell silt loam, Slope — 4½-5 percent

Treatment	Soil moisture prior to run, 0-5 in. depth, percent by weight	Water applied, in.	Total infiltration, in.	Level of significant difference, percent	Final infiltration rate*, in./hr	Soil loss, T/A	Level of significant difference, percent
Dry run (60 min)							
Conventional tillage, cultivated	8.5	2.60	2.00	1	1.70	0.83	
Minimum tillage, cultivated	9.0	2.60	2.13	1	1.85	0.52	
Minimum tillage, uncultivated	7.1	2.60	1.44		1.23	0.68	
Wet run (30 min)							
Conventional tillage, cultivated	21.8	1.30	0.79		1.32	0.67	1
Minimum tillage, cultivated	21.0	1.30	0.90	1	1.62	0.38	
Minimum tillage, uncultivated	18.7	1.30	0.72		1.23	0.30	
Very wet run (30 min)							
Conventional tillage, cultivated	—	1.30	0.62	5	1.14	0.75	1
Minimum tillage, cultivated	—	1.30	0.79	5	1.46	0.36	1
Minimum tillage, uncultivated	—	1.30	0.65		1.18	0.23	

*Average rate during last five minutes of application

Critical Unit Operations in CA Storage

Fundamental engineering considerations in analyzing heat and mass transfer

John W. Zahradnik
Assoc. Member ASAE

THE purpose of this paper is to present the fundamental engineering considerations involved in an analysis of the critical unit operations of heat and mass transfer in controlled atmosphere (CA) storage process design. In most cases, these unit operations can "make" or "break" the process.

A unit operation is defined as "the method by which an intentional or controllable change of form or place of a food material or ingredient is effected" (1)*. A unit process "is the result of an intentional or controllable change of phase or composition of a food material or an ingredient" (2). "Food material or ingredient" in the above definitions refers to food for human consumption. However, in keeping with the broad base of agricultural process engineering, the term will also be used in reference to feed for animal consumption.

The unit operations involved in the various CA processes with which this paper is concerned, if plotted on a simplified operation process chart, would appear as in Fig. 1, from which it can be seen that there are three unit operations involved in CA processes: *(a)* heat transfer, *(b)* mass transfer of gases, and *(c)* materials handling.

Because the unit operation of materials handling affects only total operational efficiency and does not fall in the category of being critical to the process, it is not discussed in this paper. However, heat transfer and mass transfer aspects of CA processes are discussed since their application to several commodities: apples (3), eggs (4), pork and bacon (5), beef (6), pears (7), nuts (8), and high moisture corn (9) have been investigated.

As with a great many other approaches to engineering design, the above-named unit operations and the equipment used in these operations are usually designed on the basis of steady-state conditions. However, because of the time element and the perishable nature of the commodities involved, particular attention must be directed to these unit operations in terms of the transient-state conditions involved. An example of the importance of these transient-state conditions is had in the law that was recently passed by New York state (10) which places a time limit of 20 days for apples to pass from the initial oxygen level of approximately 21 to 5 percent, if they are to be sold on the market under the label of controlled-atmosphere apples.

Generally speaking, the CA process can be visualized (Fig. 2) as consisting of transient-state and steady-state periods in terms of the time variable and the driving forces involved, whether the individual operation is heat transfer or mass transfer. Of particular importance to the design of certain structures and equipment is the transient-state period since the driving forces, whether they be temperature gradients or mass concentration gradients, determine the maximum capacity and size of equipment for a particular installation.

In determining size and capacity of equipment, it should be noted that the rate of mass or energy transfer usually does not have to be known with a greater accuracy than ± 10 percent. Quite often it is necessary to deal with rates that cannot be predicted more accurately than ± 25 percent. It should be further recognized, if the limits of accuracy are known, then adequate allowance in the form of safety factors in the size of equipment or capacity of equipment can be made in order to be sure that the predicted performance of the process will be obtained. This does not mean that one should not be interested in or desire precise in-

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*Numbers in parentheses refer to the appended references.

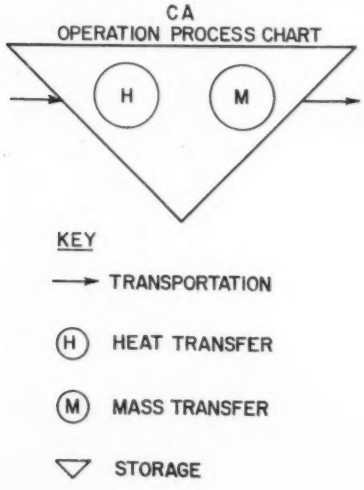

Fig. 1 *(Left)* CA operation process charted with respect to the product and the three unit operations involved

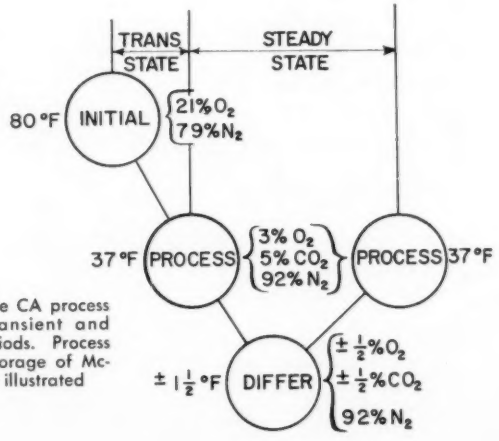

Fig. 2 *(Right)* The CA process in terms of transient and steady-state periods. Process conditions for storage of McIntosh apples illustrated

formation. It is important to have as reliable a basis as possible for process-design and process-performance calculations. Perhaps one of the chief reasons for the wide allowance in predicting capacity rates is that rarely is process equipment operated at exactly the capacity for which it was designed. Calculation of rates of transfer of mass and energy has not been developed to the same high degree of accuracy as the material balance, energy balance, and static equilibrium relations.

From elementary physics we have the relationship $I=E/R$, that is, the rate of flow of electricity is directly proportional to the electromotive force and inversely proportional to the resistance. This is a specific application of the general law that the rate at which a state of static equilibrium is approached at any instant is directly proportional to the driving force and inversely proportional to the resistance or

$$dQ/d\Theta = C \triangle F/R' \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [1]$$

where Q = quantity of mass or energy transferred
Θ = time corresponding to Q
C = a constant
$\triangle F$ = difference in driving forces
R' = resistance to the transfer

Equation [1] is applicable directly to the flow of electricity, but it can be extended to process engineering where mass transfer and energy transfer may be assumed to be through an area perpendicular to the direction of transfer. Then the rate of transfer is directly proportional to the area through which the transfer is being made and directly proportional to the driving force.

$$dQ/d\Theta = C \triangle FA/R \quad . \quad . \quad . \quad . \quad . \quad . \quad [2]$$

where A = area perpendicular to the direction of transfer
R = resistance to transfer per unit area.

Equation [2] is generally applicable to engineering processes although it may be difficult in some cases to determine the actual area.

In terms of equation [2], the unit operations of heat and mass transfer will be discussed.

Heat Transfer

In the majority of cases, the predominating natural environmental conditions will determine what particular efforts must be made to maintain design temperatures. In some processes, as in the storage of high moisture corn, natural environmental conditions are such that temperatures fall below the critical point for rapid product deterioration and no special effort is made to create low temperatures. However, the cases where the natural environmental conditions are such that a successful process can be had are quite limited and in most instances artificial cooling must be employed. The required capacity of cooling systems is affected by a wide range of factors. Among them are: the heat transmission from the ambient to the process through the equipment or structure involved; the sensible heat that must be removed initially from the product while it is being cooled; the rate at which heat can be removed from the product as it is stacked in the storage, or the thermal diffusion of the stack; the rate of initial cooling, and the variation in the total cooling load with time.

In particular, the factor of the variation in cooling load with time may prove to be of considerable economic significance. From the theoretical standpoint, if the various heat loads on a 10,000 box refrigerated apple storage during the initial loading are totaled, it is found that the heat of transmission, the sensible heat, and the respiration heat total approximately 158,000 Btu per hour (11). If these general loads on the storage are totaled for the holding period, the load comes to approximately 16,590 Btu per hour, roughly one-tenth of the initial load. These calculations are further substantiated by Fig. 3 which shows *(a)* the variation in cooling load in terms of degree days and *(b)* the percent of time that a thermostat in a 10,000-box CA room was calling for refrigeration during the months of October through February. Also plotted on this particular chart for comparative purposes is a control room in which the evaporator blower was operating 100 percent of the time. This graph not only shows the wide variation in heat transfer requirements on a refrigerated fruit storage, but also the effect of programming blower operation with a thermostat. Approximately 24 percent reduction in time when the thermostat was calling for refrigeration can be achieved by recognizing this variation in heat transfer requirements. If one projects the economic aspects of this saving, it can be shown that a 7 percent reduction in electric costs can be achieved through the application of this particular specification.

Further benefits of this type of controlled blower operation may be realized in considering some of the mass transfer aspects of this type of storage.

Mass Transfer

In the case of controlled-atmosphere storage for apples and eggs, the creation of an artificial atmosphere is achieved

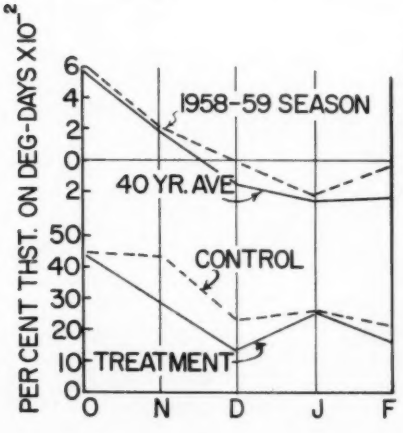

Fig. 3 *(Left)* Cooling load variation on a monthly basis for a 10,000-box CA apple storage and thermostat demand pattern with and without 100 percent blower operation. (Temperature data are for Massachusetts)

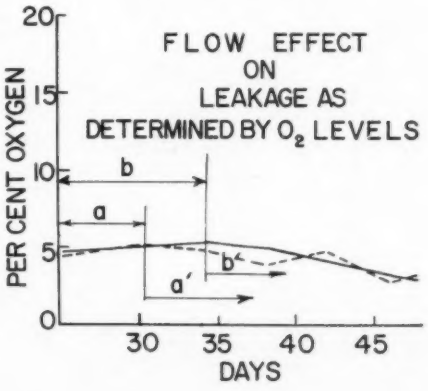

Fig. 4 *(Right)* Effect of internal atmosphere flow on gross mass transfer through the gas seal of a 16,000 box CA apple storage. Periods *a* and *b* indicate excessive infiltration under high internal flow. Periods *a'* and *b'* indicate reduction in infiltration under low internal flow

biologically; that is, the necessary concentrations of the various gases in the atmosphere are permitted to build up to the desired level as a result of metabolic changes occurring in the product.

In some of the other controlled-atmosphere processes, such as the preservation of high moisture content alfalfa for pharmaceutical purposes and the ripening of bananas, the desired atmosphere is created artificially by the injection of appropriate gases. The rate of mass transfer of the atmosphere through the gas seal in the room is critical in the case of the biologically achieved atmosphere, since the rate of production of gases is accompanied by a corresponding deterioration in the product. In the case of the artificially created atmosphere, there is only an economical limit to the rate at which leakage of the atmosphere through the room can be permitted. In some cases it is possible to use a combination of both the artificial method and the biological method of achieving the desired atmosphere. It should be recognized that several of the commodities which we have referred to, in order to maintain desired product quality, must be stored as living plant tissue.

The single variable of greatest importance affecting the driving forces, as far as mass transfer is concerned, out of the product into the atmosphere, is the temperature-gradient effect. There are some minor variables, such as variety and state of maturity, but the temperature effect is the dominating and controlling variable. In general, the higher the temperature that is maintained, the more rapidly can the atmosphere be achieved when using the biological method of creating the atmopshere. However, at higher temperatures the quality of the product deteriorates rapidly, so that in most cases, the temperature is lowered to near the freezing point and the rate of leakage of the atmosphere from the storage is controlled to such a point that the necessary atmosphere will be created in the shortest possible time. The rate of transfer of the atmosphere from the inside of the storage to the outside must be controlled to such a point that certain of the gases will increase in concentration to the desired level. The permeability and the wall surface area exposed is a determining factor in this rate of leakage. However, certain other variables enter, such as the flow of the atmosphere inside the room (12). In Fig. 4, the effect of internal movement of the atmosphere is illustrated. This ties in with the factor mentioned under heat transfer, of programming evaporator blower operation by means of a thermostat. This practice of programming blower operation not only cuts down on the internal heat load generated by equipment in the storage but also on the rate of mass transfer of the atmosphere in the storage to the outside. Exfiltration and infiltration may be minimized through the use, on certain CA processes, of breather bags (13) to compensate for pressure fluctuation due to temperature variations. In certain other processes, such as the storage of high moisture corn as reported by Isaacs (9), the zero pressure venting system can be used.

However, of all the factors mentioned, the one which is of greatest significance is the factor of time involved in order to achieve the necessary mass transfer. This is important because the rate of product deterioration is also a function of time, and the size and capacity of equipment is determined by the time permitted to perform its various functions. Because of the great significance of the time element in respect to mass transfer and heat transfer in the design of controlled-atmosphere storage processes, special consideration is given here to the transient state conditions. This is a projection of the work of Pflug and Dewey (14) in their consideration of the theoretical relationship of the variables affecting the operation of a CA storage. The above work was a valuable contribution toward the understanding of CA processes under steady-state conditions. However, since it is not the steady-state conditions which determine the critical capacities in mass transfer and heat transfer equipment, it is important to evaluate the variables under transient-state conditions.

The actual path of the variables under transient-state conditions, whether dealing with heat or mass transfer, can be defined through the use of the calculus (15) since rates of change are being defined in terms of a time variable. While this actual path is of considerable academic interest, it is not of great significance to the CA process equipment designer since equipment must perform satisfactorily under the maximum load conditions and especially in the case of mass transfer equipment, capacity variations do not yield significant economic advantages. Therefore, from the designer's standpoint, it is primarily the initial maximum increment of the load which must be used to design the capacity of the equipment or structure. If the equipment is not capable of handling this initial maximum increment, it is of little use since the next smallest increment of load will not be reached and the processes will fail.

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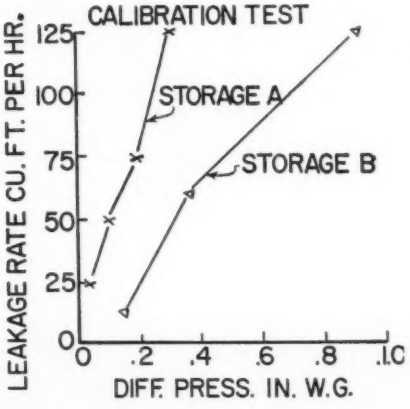

Fig. 5 *(Left)* Mass transfer field evaluation by means of the pressure-calibration test

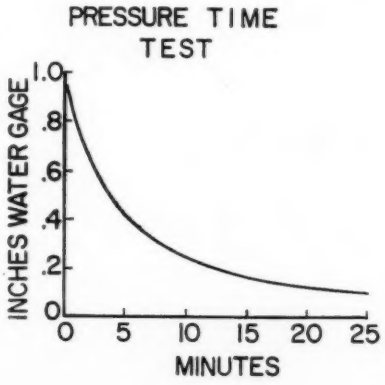

Fig. 6 *(Right)* Mass transfer field evaluation by means of the pressure-time test

Drainage System Endurance in Organic Soils

W. A. Cutler, R. Z. Wheaton, and E. H. Kidder
Member ASAE *Assoc. Member ASAE* *Member ASAE*

A seven-year study of a drainage system in organic soils provides valuable information on durability and stability of underdrains and surface subsidence

THE tile drainage system on the Michigan State University muck experiment farm near East Lansing was constructed in the early 1940s. The total area drained was approximately 50 acres. A 12-in. vitrified shale main discharges into a reservoir ditch. A propeller-type drainage pump lifts the water from the reservoir ditch to a gravity outlet. Six-inch vitrified shale laterals were installed to provide for profile drainage and subirrigation by means of water-level control.

Plans were made for the expansion of the cultivated area in 1951. This provided an opportunity for a drainage research study which was started in 1952.

Materials and Methods

The soil in the newly developed area was classified as Houghton muck. The soil profile consists of a surface layer of 6 to 8 in. of finely divided black muck, a subsurface layer from approximately 8 to 36 in. of sedge peat containing some tamarack roots and other woody material, then a layer below 36 in. of coarse fibrous material which showed only slight decomposition. The depth of the organic soil varies from 8 to 15 ft. The area is well-protected by vegetative windbreaks. For this reason, the soil loss by wind erosion is negligible.

In June 1952 the main was extended 80 ft and four laterals were installed at the upper end of the main to determine the stability of tile laterals in organic soils, the durability of concrete tile, perforated galvanized steel pipe, and perforated fiber pipe, and to collect data on the subsidence of the soil surface following underdrainage (Fig. 1). The tile were placed in peaty material at depths of 4.0 to 4.5 ft. The laterals were spaced 60 ft apart and each lateral was about 750 ft long. Vitrified shale draintile 6 in. in diameter and 2 ft in length were used with the exception of the durability experimental sections which were located at the upgrade ends of each of the laterals (Fig. 1). Concrete draintile, 6 in. in diameter and 1 ft in length from two manufacturers were placed at the upper end of lateral No. 1. Concrete draintile 6 in. in diameter and 1 and 2 ft in length from two additional manufacturers were placed at the upper end of lateral No. 2. Approximately 100 ft of concrete tile from each manufacturer were installed. Thirty-two feet of 6-in. perforated galvanized pipe was installed at the upper end of lateral No. 3. Twenty-four feet of 4-in. perforated bituminous fiber pipe was installed at the upper end of lateral No. 4.

Varying thicknesses of dry marsh hay blinding material were placed over selected sections of the laterals. Marsh hay was used as a blinding material because it has been found by experience that there is less deterioration in this type of material than in ordinary straw or tame hay. The elevations of the top of the tile at 20-ft intervals were determined and recorded when the laterals were installed. The elevation of the top of the tile lines are redetermined annually at the same 20-ft locations by use of accurate leveling equipment and tile probes. Soil surface elevations are obtained yearly at 100-ft intervals and at an offset of 10 ft to the north of each lateral.

The concrete tile were obtained from four manufacturers because of a difference in their curing processes. All of the concrete tile were manufactured on packer-head machines. Manufacturer No. 1 used water curing. Manufacturer No. 2 used low-pressure steam curing. Manufacturer No. 3 used low-pressure steam curing and manufacturer No. 4 used air-curing methods. A very good job of packing was accomplished by manufacturer No. 4 with an automatic packer-head machine. Approximately 105 ft of concrete tile were delivered by each manufacturer except No. 3 so that a standard test sample of five one-foot lengths could be selected. Manufacturer No. 3 delivered approximately 100 ft of two-foot lengths and 10 ft of one-foot lengths for test sampling. A standard sample of five sections of tile was selected for test purposes from each manufacturer's tile. These were tested for strength and absorption according to ASTM specifications C4-50T. Six-inch vitrified-shale draintile in two-foot lengths were selected as the basic material in this study for stability measurements. Research and experience have shown that organic soil acids have no effect on high quality clay draintile*.

According to initial plans made in 1952, a four-year interval detailed examination of materials was made on November 8, 1956. Two feet of concrete tile were removed at three stations for each of the four concrete tile manufacturers represented. Tile were photographed prior to being tested, according to ASTM C4-55 specifications for strength and absorption. The perforated steel and fiber pipe was examined for evidence of deterioration. The thickness of marsh hay used for blinding was examined to determine the amount of decomposition. Accumulation of sediment in the tile at each test location was noted. Six additional feet

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The authors—W. A. CUTLER, R. Z. WHEATON, and E. H. KIDDER—are respectively, assistant professor, instructor, and associate professor in the agricultural engineering department, Michigan State University, East Lansing.

Acknowledgment: The authors acknowledge the assistance of J. F. Davis, L. N. Shepherd, R. E. Lucas, R. M. Gillespie, P. E. Schleusener, J. R. Davis and the five tile manufacturers who participated in the installation and conduct of the research.

*Clay tile are made of surface clay, shale, fire clay or mixtures thereof.

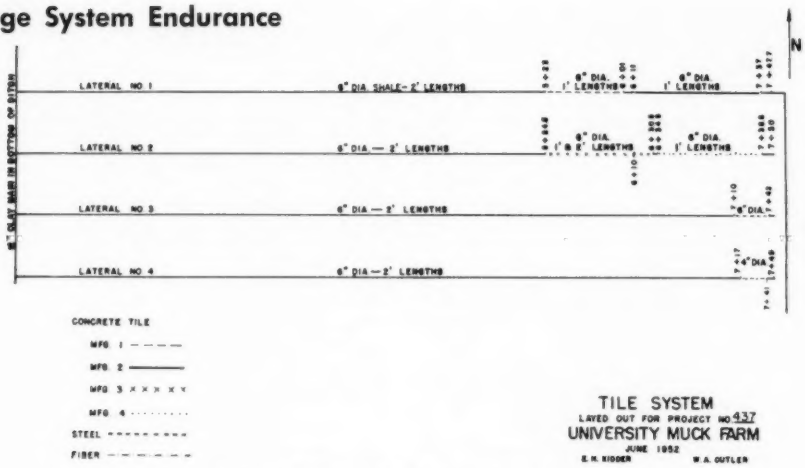

Fig. 1 Location of tile main, laterals and durability test sections

of tile from manufacturer No. 4 were removed in November 1958. They were visually examined, photographed and retained for testing with the samples to be removed in 1960.

A control box was placed in the 12-in. main in 1957 to control the water level in this newly developed area.

Results

The soil surface and top of tile elevations for lateral No. 4 are shown for the years 1952, 1953, 1956 and 1959 in Figs. 2 and 3. Fig. 2 shows a surface subsidence of about 0.4 to 1.0 ft for the first 580 ft of the line during the first year following construction. A lesser amount of subsidence is shown in the following years. The area from station 5+80 to 7+50 on all laterals remained in bluegrass sod until the spring of 1956. The subsidence on this area was about 0.6 ft during the first two years following drainage and an additional 0.1 to 0.2 ft from November, 1955, to November, 1956. The elevations taken on the top of the tile show a subsidence of about 0.3 ft the first year following installations with only minor elevation changes in the following years (Fig. 3). The apparent greater depth from station 7+20 to the end of lateral No. 4 results from the use of 4-in. diameter fiber pipe and 4-in. tile. The remainder of the lateral had 6-in. diameter vitrified shale tile.

The tile elevations for the first 540 ft of lateral No. 4 taken in 1956 appear to be above those in previous years. About 6.25 in. of rainfall in 35 days preceding the measurement of elevation on August 28 may have caused some swelling of the muck soil. The August 28 elevation of a temporary bench mark on a Chinese elm tree located in the northwest corner of the area was 0.05 ft above the elevation taken on November 8 when the balance of the elevations on top of the laterals were taken. Every time a level survey is made, the elevation of the temporary bench mark is redetermined with reference to the elevation of the permanent bench mark.

With the exception of the original elevations during installation in June, 1952, and those taken on August 28, 1956, all levels were run on or about November 8 of each year.

The tile from manufacturer No. 1 on the original test showed 1237 lb strength tests with an absorption of 7.0

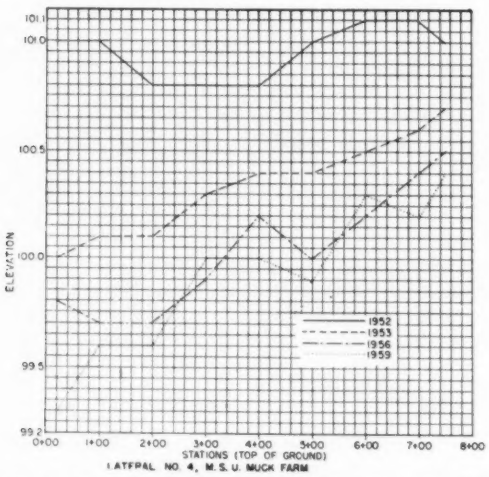

Fig. 2 Soil surface elevations for lateral No. 4 in 1952, 1953, 1956 and 1959

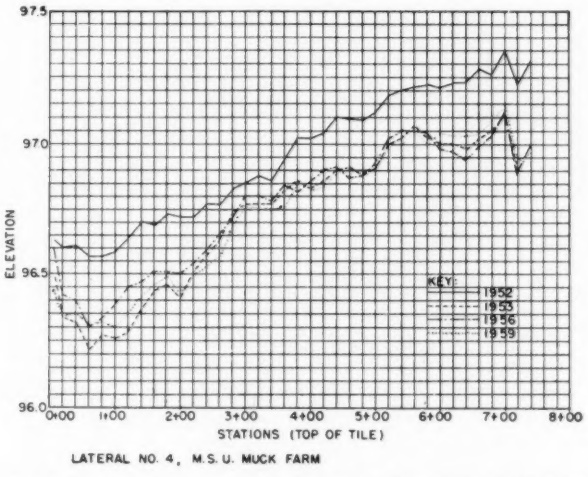

Fig. 3 Top of tile elevations for lateral No. 4 in 1952, 1953, 1956 and 1959

Fig. 4 Acid-etched tile removed from station 6+53 on lateral No. 2 in 1958. Etching was more pronounced on the sides than on the top and bottom

Fig. 5 Replacement shale tile in place and hay blinding material in excellent condition after four years

Fig. 6 Test sections removed show no sediment in hay blinded lateral

percent. After four years, six individual tile were tested and the strength was 1021 lb per lineal foot with an absorption of 9.0 percent. During four years both the strength and absorption of this manufacturer's tile dropped from extra quality to standard quality.

Original tests of manufacturer No. 2 showed 1125 lb strength and 7.0 percent absorption. After four years, and based on six samples of tile, the strength showed 1279 lb per lineal foot with an absorption of 8.7 percent. In this case, the strength remained as extra quality and the absorption changed from extra quality to standard quality.

Tile from manufacturer No. 3 on the original tests showed a strength of 1062 lb per lineal foot and an absorption of 6.5 percent. After four years, the strength on the six individual tile samples averaged 1698 lb per lineal foot with an absorption of 7.6 percent. The original strength test showed standard quality, but during four years there was an apparent strength increase which made the test show extra quality. The absorption after four years remained in the extra-quality classification. The inconsistency in the two strength tests is believed to have resulted from the selection of the original test samples. This manufacturer furnished two-foot lengths of tile and was asked to furnish about ten tile in one-foot lengths for testing purposes on the original test procedure. It is believed that the original one-foot lengths of tile supplied for testing were not representative of the special two-foot lengths of tile which were placed in the organic soil.

The original samples of tile tested for manufacturer No. 4 showed a strength of 1000 lb per lineal foot and an absorption of 8.3 percent, which placed these tile in the standard quality classification. After four years the strength of the six individual tile tested was 732 lb per lineal foot with an absorption of 10.5 percent. These tile no longer met the standard quality specifications. Six tile from this manufacturer were removed in 1958 and visually examined (Fig. 4). More acid etching was noted in 1958 than in 1956.

An examination of the concrete tile before testing after they had been in the organic soil for four years showed that most of the etching and pitting was on the sides of the tile with little, if any, on the top and bottom quarters. Many specimens showed considerable etching on the sidewalls but no etching on the bottom quarter of the tile. The pH of the soil at tile depth in the experimental area ranged from 6.4 to 6.6. This range is classified as slightly acid.

The perforated steel and fiber pipe appear to be functioning satisfactorily after being in the organic soil for four years. A considerable amount of rusting was noted on the galvanized steel pipe. Internal diameter measurements were taken of the bituminous fiber pipe and these showed a slight flattening of the pipe since the horizontal dimension was 0.1 in. greater than the vertical dimension.

The marsh hay used for blinding during the original installation was in excellent condition after four years (Fig. 5). At many of the test locations, it retained its original greenish color. In the section where depths of 18 to 24 in. of loose hay were placed over the tile during installation, an excessive amount of hay still remained in the trench. It showed no evidence of deterioration. Where an average depth of 6 in. of marsh hay was used for blinding, it was noted that 1½ to 2 in. of compressed hay material remained over the tile on the lateral lines. The marsh hay blinding

(Continued on page 85)

Gas Turbine Crop Drier

Donnell R. Hunt
Member ASAE

High waste heat output of gas turbine engines suggests their use as crop-drier power units

WITHIN the past ten years the importance of the farm crop drier has risen from obscurity to significance. Farmers now recognize artificial drying as economically beneficial in reducing harvesting losses and harvesting time, and in retaining the quality of the harvested crop.

Conventional heated-air, farm crop driers use a fan to produce air flow and a fuel burner to add heat to the air flow. With the growing demands for increased drying capacity, internal-combustion engines are being used to power the fan instead of electric motors formerly used, since there is limited electric service available on most farms. In many cases, the farm tractor is used as the fan power unit.

A more suitable drier design would be a single mechanism which would burn the required quantities of fuel and simultaneously extract enough mechanical energy to cause appropriate air flow. An energy analysis of present-day heated-air driers indicates that less than 2 percent of the total energy output is in the form of air flow while the remaining 98 percent is sensible heat. This unique proportion of mechanical and thermal energy implies the possibility of a special power unit, significantly different from any other in the agricultural field.

As a class, gas turbine engines have a high waste heat output and logically can be considered as crop-drier power units. While it is feasible to gear the fan to the gas turbine, a simpler design would result if an induction action is used for air flow. The gas turbine then becomes only a high velocity hot gas producer or gasifier.

This paper reports the investigation (1)* into the concept illustrated in Fig. 1, that of a gas turbine and air inductor used for crop drying. The primary fluid flow is created by the turbine and is introduced into the throat of the mixing tube by a converging nozzle. Secondary flow occurs as a result of a pressure drop created at section 1 (Fig. 1) by the primary fluid entraining the surrounding fluid and carrying it down the mixing tube. A pressure rise due to the

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*Numbers in parentheses refer to the appended references.

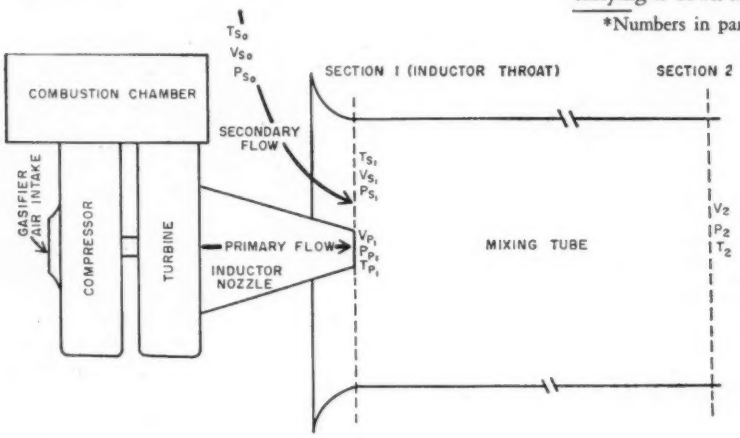
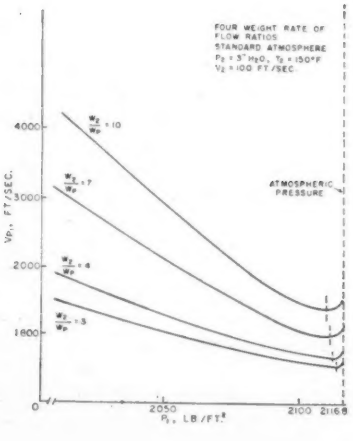


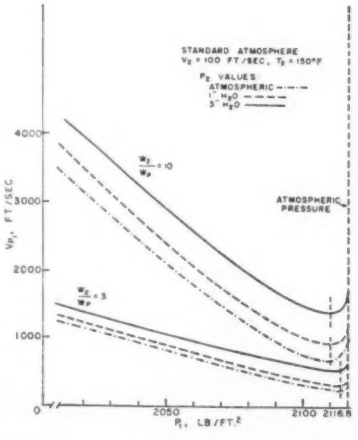
Fig. 1 *(Left)* **Diagram of gas turbine-air conductor crop drier**

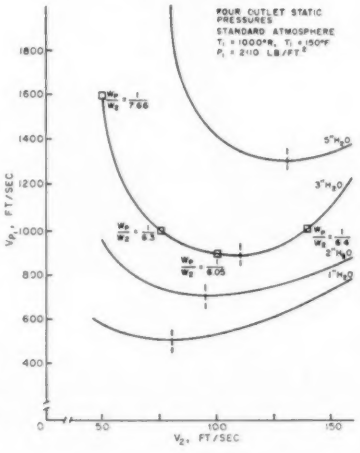
Fig. 2 *(Bottom left)* **Nozzle velocity requirements vs. inlet static pressures for four weight rate of flow ratios**

Fig. 3 *(Bottom center)* **Nozzle velocity requirements vs. inlet pressures for two weight rate of flow ratios**

Fig. 4 *(Bottom right)* **Nozzle velocity requirements vs. exhaust velocities for four exhaust static pressures**







ANALYSIS OF GAS TURBINE PERFORMANCE

With respect to the inductor action the following assumptions were made:

The working fluid obeys the perfect gas laws

Conduit friction is negligible

All processes are adiabatic

Complete mixing of primary and secondary streams occur within the mixing tube

Section 1 (Fig. 1) is assumed to be an iso-pressure plane.

The following symbols and units were used:

V = velocity, feet per second

P = absolute pressure, pounds per square foot

T = absolute temperature, degrees Rankine

R = specific gas constant, feet per degree Rankine

w = specific weight of fluid, pounds per cubic foot

W = weight rate of flow, pounds per second

U = internal energy, Btu per pound

H = enthalpy, Btu per pound

C_p = specific heat for constant pressure, Btu per pound — degree Rankine

C_v = specific heat for constant volume, Btu per pound — degree Rankine

g = acceleration of gravity, fps^2

J = heat equivalent of work, foot-pounds per Btu

k = ratio of specific heat constants

A = area, square feet

M = mass rate of flow, pounds—second per foot

E = total energy, Btu per pound

Subscripts 1 and 2 refer to conditions at section 1 and 2. Subscripts p, s, and o refer to primary, secondary and atmospheric fluid flows respectively.

The following three general equations are applicable to flow through the inductor:

Continuity equation—

$$W_{p1}+W_{s1}=W_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad [1]$$

Momentum equation—

$$(P_2-P_1)\ A_2=M_{s1}\ V_{s1}+M_{p1}\ V_{p1}-M_2\ V_2 \quad . \quad . \quad . \quad . \quad [2]$$

Energy equation—

$$E_{p1}+E_{s1}=E_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [3]$$

The combination of equations [1] and [2], the substitution of W_2/g for M_2 and the substitution of $W_2/w_2 V_2$ for A_2 gives:

$$\frac{W_p}{W_2}=\frac{g(P_2-P_1)}{w_2 V_2\ (V_{p1}-V_{s1})}+\frac{V_2-V_{s1}}{V_{p1}-V_{s1}} \quad . \quad . \quad . \quad [4]$$

A low ratio of W_p to W_2 indicates a large, induced secondary flow. Such a low ratio results if the pressure rise from section 1 to section 2 is small; a large velocity difference exists between primary and secondary fluid streams and a small velocity difference exists between the secondary flow and the final flow. These qualifications match quite closely a crop drier's characteristics of low static-pressure output, a low atmospheric-air velocity and low drying-air velocities. It would appear that the inductor action is quite suitable for crop-drying applications.

Equation [3] can be expressed as:

$$W_p\left(U_{p1}+\frac{P_1}{w_{p1}J}+\frac{V_{p1}^2}{2gJ}\right)+W_s\left(U_{s1}+\frac{P_{s1}}{w_{s1}J}+\frac{V_{s1}^2}{2gJ}\right)=W_2\left(U_2+\frac{P_2}{w_2 J}+\frac{V_2^2}{2gJ}\right) \quad . \quad . \quad [5]$$

Using the enthalpy concept that $dH=C_p\,dt$ and the continuity equation, equation [5] was written as follows:

$$\frac{W_p}{W_2}=\frac{2gJC_p\ (T_2-T_{s1})+V_2^2-V_{s1}^2}{2gJC_p\ (T_{p1}-T_{s1})+V_{p1}^2-V_{s1}^2} \quad . \quad . \quad [6]$$

Equations [4] and [6] are related to each other through the weight rate of flow ratio. In addition to velocity and pressure relationships indicated by equation [4], equation [6] demands a high primary-stream temperature and low final and secondary-stream temperatures for a low W_p/W_2 ratio.

The secondary flow variables may be eliminated by writing an energy equation along the secondary stream from atmospheric conditions to conditions at section 1. Assuming V_o as a negligible quantity, the equation for secondary stream velocity at section 1 becomes:

$$Y=V_{s1}=\sqrt{2gT_o\,R\,k/k-1\ [1-(P_1/P_o)^{(k-1)/k}]} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [7]$$

Rewriting the secondary stream temperature-pressure relationship between atmosphere and section 1 gives:

$$X=T_{s1}=T_o\ (P_1/P_o)^{(k-1)/k} \quad . \quad . \quad [8]$$

For simplicity, V_{s1}^2 was set equal to Y^2 and T_{s1} to X.

Equation [9] combines equations [4], [6], [7], and [8] to describe the inductor action in terms of atmospheric conditions, tube outlet conditions and turbine delivery conditions.

$$\frac{(P_2-P_1)\ g+w_2 V_2\ (V_2-Y)}{w_2 V_2\ (V_{p1}-Y)}=\frac{2gJc_p\ (T_2-T_oX)+V_2^2-Y^2}{2gJc_p\ (T_{p1}-T_oX)+V_{p1}^2-Y^2}=\frac{W_p}{W_2} \quad . \quad . \quad . \quad . \quad . \quad [9]$$

If one assumes standard atmospheric conditions and various typical drier output values for the final conditions, only P_1, T_{p1} and V_{p1} remain as variables.

Solutions of the equation were obtained by assuming numerical values of two of the primary flow values and solving for the third. Upon plotting portions of the equation, two unique and optimum values for P_1 and V_2 were discovered. Figs. 2, 3, 4, and 5 indicate that at approximate values of $V_2=100$ fps and $P_1=2110$ lb per square foot absolute, a minimum value of V_{p1}, nozzle velocity, is required to produce a given drying-air output. Using these two minimum values, Fig. 6 was plotted to show the required gas turbine performance as to temperature and velocity to produce various final air flow quantities, temperatures, and pressures. The physical size of the gas turbine is seen to depend upon the final weight rate of flow desired.

conversion of velocity head into static head occurs as the combined fluids flow from section 1 to section 2 (Fig. 1). An analysis of gas turbine performance is shown in box.

Power Unit Development

The gas turbine was shop-produced from a military aircraft turbosupercharger shown in Fig. 7. This unit has a centrifugal compressor mounted on a common shaft with an axial-flow turbine. The lubricant circulating pump was adapted to also serve as the fuel pump. Internal sealing of the turbine housing was necessary. A stainless-steel combustion chamber, burners, an ignition system, cranking facilities, and a converging nozzle were added. The recommendations of Keenan and Neumann (2) were followed in positioning the turbine nozzle relative to the mixing tube. Fig. 8 shows the completed unit as mounted on the transport chassis.

Cranking was accomplished by belting from a farm tractor. Nearly 15 hp was required to produce the self-sustaining speed of 4000 rpm. Operating speed was regulated by fuel flow and reached a peak of 11,000 rpm under no load with a fuel consumption of 20 gal per hour of kerosene.

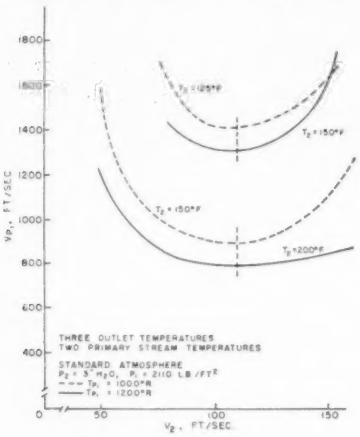


Fig. 5 *(Top left)* Nozzle velocity requirements vs. exhaust velocities for varying temperature conditions

Fig. 6 *(Bottom left)* Primary temperature and velocity requirements for various typical crop-drying conditions

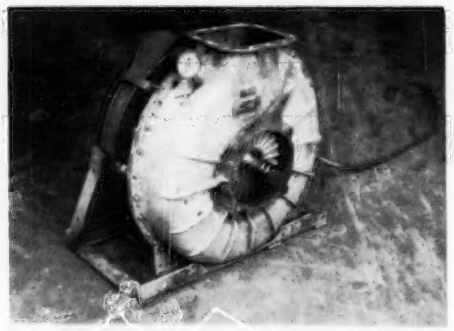


Fig. 7 *(Top right)* Aircraft turbosupercharger used to build the gas turbine

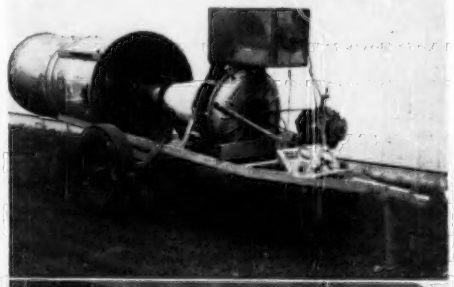
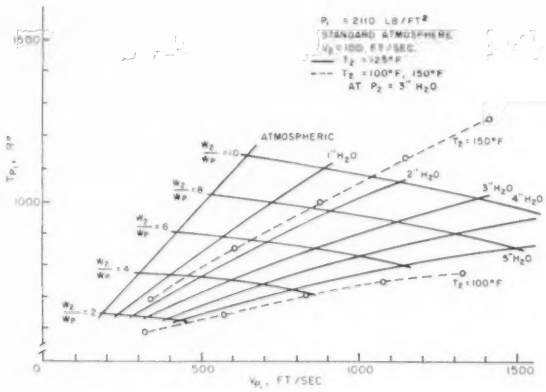


Fig. 8 *(Center right)* Completed gas turbine crop drier

Fig. 9 *(Bottom right)* Test site



Testing

The test objectives were to measure the output from the mixing tube with variations in gasifier delivery and compare with the theoretical analysis.

Fig. 9 shows the test site. A large tube equipped with a throttling valve served as the receiver. By closing this valve, delivery characteristics against pressure could be checked. Velocity measurements were accomplished with pitot tube traverses. Water manometers were used for pressure measurement and iron-constantin thermocouples were used to measure temperature.

Results

The inefficiency of the shop-produced gasifier limited the range of the test runs. Four sizes of gasifier nozzles were to have been used to give a wide range in primary stream velocity. It soon became apparent that the gas turbine could deliver only through the largest nozzle, producing a maximum gas velocity of 480 fps. At such a low delivery, the maximum mixing tube outlet pressure obtainable was but ½ in. of water. Fig. 6 indicates that a required gas turbine output for a typical drying process, 125 F, 3 in. water pressure, 100 fps air velocity, would be 1,000 fps at a temperature of 900 R. For such a situation the thermal efficiency of the power unit would need to be 18 percent, which is near the upper limit for simple gas turbines. The greatest measured thermal efficiency obtained during the tests was 2 percent. In order to achieve high output, it was necessary to operate the gas turbine at primary nozzle temperatures up to 1500 F. At such temperatures only intermittent operation was possible.

In Fig. 10 the relationships between primary nozzle velocity and mixing tube outlet velocity for receiver pressures of atmospheric and ½-in. water pressure appear linear and possess a positive slope. Total delivery from the mixing tube was reduced when discharging into the higher pressure.

Fig. 11 compares the weight rate of flows of the primary and mixing tube gas streams with the theoretically predicted values for receiver pressures of atmospheric and ½-in. water pressure. The theoretical weight ratios of flow were determined by using both the energy relation and the momentum relation. Nozzle velocity, pressure, and temperature measurements made for a specific test were substituted in the theoretical relations. The solutions were compared with the measured mixing-tube exhaust conditions. Fig. 11 indicates close agreement between theoretical and measured values with the exception of the momentum equation at atmospheric discharge pressure. This discrepancy is thought to be insignificant since the momentum equation requires a

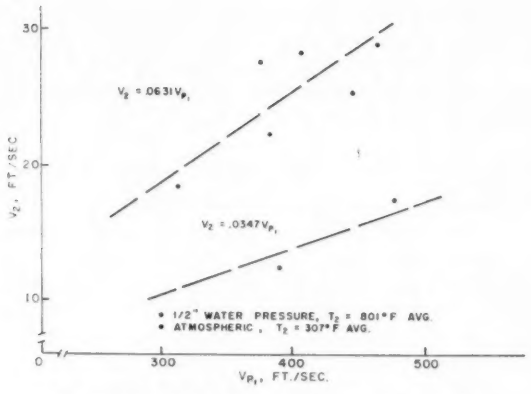


Fig. 10 Mixing tube final velocity vs. nozzle velocity

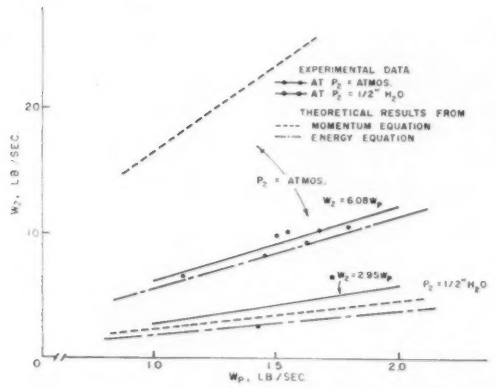


Fig. 11 Comparison of theoretical and actual weight rate of

very accurate determination of the static presure at section 1. If this pressure had been read to be 0.1-in. of water less, the momentum equation prediction would have matched the energy prediction equation.

It was concluded that the gas turbine-inductor configuration is feasible as a crop drier. It would appear that more development is required for a satisfactory and reliable power unit. Effort can be made in either of two directions. The inductor may be used with a high output gas turbine or a special gasifier might be built to produce a satisfactory drying airstream directly from the turbine housing. A gas turbine crop drier would have several operational advantages. It could be adapted to burn any liquid fuel without a heat exchanger since combustion is complete. It would be physically small for its capacity, portable, and independent of electric lines or other auxiliary power. Two major disadvantages are the inability to perform the cooling-out function desired in most heated-air batch drying and the fact that the gas turbine drier would not lend itself easily to automatic control.

As progress is made in gas turbine development, particularly in the automotive field, it is reasonable to expect mass production methods will lower the manufacturing costs to the point where such engines may be used quite economically in the agricultural field. As a crop drier, such a power unit will have a unique application.

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. . . Drainage System Endurance

(Continued from page 81)

material was again observed in 1958 when additional samples were removed. The hay was in excellent condition. Sediment was not observed in the tile lines even in sections where marsh hay blinding was not used. Fig. 6 shows the lack of sediment in a hay-blinded line.

Discussion

The results obtained in this research indicate that there was a definite deterioration in quality of concrete tile due to the effect of organic soil acids. This study will be continued and samples of concrete tile will be removed and tested each four years during the life of the study.

When the tile main was installed, it was placed on boards and other stabilizing material. This main had been in place for about 10 to 12 years prior to the start of this study. The 80-ft extension installed in 1952 was bedded in peat. From the level survey information taken, the tile main has not settled appreciably since the lateral tile were installed in 1952. It was noted on the profile of each lateral that a definite settlement has occurred near the tile main. It might be well, in actual practice, to recommend that the lateral lines be laid on a rather steep grade for the first 50 ft in order to offset the settlement that takes place in the lateral at this location.

The tile laterals were placed at an average depth ranging from 4.0 to 4.5 ft and they were laid on fibrous peaty material. If the laterals had been placed in unstable muck, then some type of stabilizing material would have been placed under the line in order to keep the lateral tile from settling out of place. (This stabilizing material could include three new types of material which have recently been placed on the market. These materials include a glass-fiber material reinforced with glass fiber yarn and impregnated with a bituminous mixture, a vinyl plastic and a rigid polyethylene. They are made in roll form of various widths so that they can be laid in the bottom of the trench inside the shoe of the trenching machine.)

Conclusions

1 The soil surface subsidence was 0.4 to 1.0 ft the first year following drainage with little subsidence the following six years.

2 The tile settled about 0.3 ft the first year following drainage with very little change in the next six years.

3 Three of the four manufacturers' concrete tile showed deterioration in quality in four years.

4 Rusting was observed on the galvanized steel pipe.

5 A slight flattening of the bituminous fiber pipe occurred.

6 The marsh hay blinding material remained in excellent condition for six years.

. . . Minimum Tillage for Corn

(Continued from page 75)

cultivation of the cultivated treatments. Less than 4 inches of rainfall occurred between the second cultivation and these runs. The soil was extremely dry prior to the Series C runs.

The infiltration and soil loss for the third series of runs are given in Table 3. The total infiltration and the infiltration rates were generally higher during the third series of runs than for either of the first two series. This is largely attributed to the low moisture content of the soil profile. The infiltration of the cultivated treatments was again greater than the uncultivated treatments. The difference was probably greater than could be expected in an average year due to the low natural rainfall and the severe crusting from the large amount of prior simulated rainfall on the soil surface of the uncultivated treatments. The amount and rate of infiltration of the cultivated minimum tillage treatments continued to be greater than those of the conventional treatment, and the difference in rates increased with successive runs. The infiltration rates of the conventional and uncultivated minimum tillage treatments were again similar during the wet runs. Total infiltration for the three runs was: conventional, cultivated, 3.4 in.; minimum tillage, cultivated, 3.8 in., and minimum tillage, uncultivated, 2.8 in. Runoff was 1.8, 1.4 and 2.4 in., respectively.

The relatively minor soil losses during the series C runs as compared to those of the other two periods were due to greatly reduced soil content of the runoff. The uncultivated treatments had a dense growth of grass between rows and were therefore well protected from soil movement. The cornstalks were the only cover of any influence on the cultivated treatments; yet soil losses were also low. The cultivated minimum-tillage treatments again produced consistently less soil loss than the conventional treatment. Soil losses from the three runs totaled: Conventional, cultivated, 2.4 tons per acre; minimum tillage, cultivated, 1.2 tons per acre, and minimum tillage, uncultivated, 1.1 tons per acre.

Summary of the Three Series of Runs

The total infiltration, soil loss, and runoff from the three series of rainulator runs is shown in Fig. 4. Each series is divided into the three runs made. The relationship between the runoff and soil loss is very evident. The infiltration rates at the end of each run are summarized in Fig. 5. These rates show the significant effect of minimum tillage and cultivation in increasing infiltration.

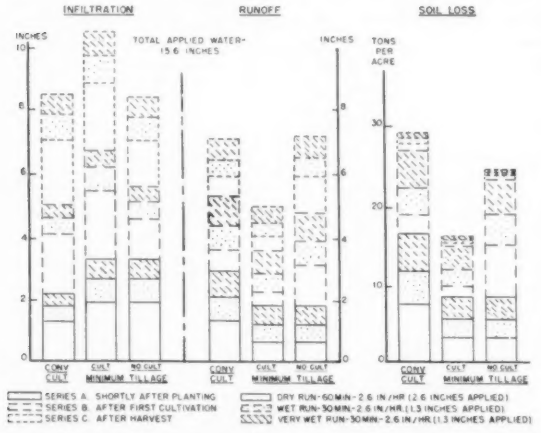

Fig. 4 Total infiltration, runoff and soil loss from all rainulator runs of the initial year of tillage study. Treatments are cultivated conventional tillage, cultivated minimum tillage, and uncultivated minimum tillage

DISCUSSION

Minimum Tillage vs. Conventional Tillage

The conventional and minimum tillage treatments can be compared from the reported research. However, only the minimum tillage treatments which were cultivated should be used after the first series of runs since the conventional treatment was also cultivated. Comparison of these treatments from Tables 1, 2, and 3 or Figs. 4 and 5 shows that the infiltration of the minimum tillage treatments was greater for all runs which agrees with other investigations (14). Also, the soil loss from the minimum tillage treatments was consistently less for all runs. Since runoff is the difference between application and infiltration, soil loss differences between treatments during the initial year of study were largely due to the differences in infiltration rates.

Soil loss from the minimum tillage treatments was 35 to 50 percent less than loss from the conventional treatment. This reduction agrees with the 40 percent soil loss reduction attributed to minimum tillage by Pierre and Wischmeier (12).

The lasting value of minimum tillage after meadow in decreasing soil bulk density was shown by measurements which were made ten months after the treatments were applied. Samples were obtained at a 2 to 4-in. depth between corn rows. Bulk density averaged 1.18 gm per cc for the minimum tillage treatments and 1.40 gm per cc for the conventional treatment. Similar differences were reported from another study (14).

Cultivation vs. No Cultivation

Comparison of the cultivated and uncultivated minimum treatments shows that infiltration was greatly increased and soil loss was decreased by cultivation. The cultivation eliminated the severe surface crust resulting from previous rainfall. In addition to much greater runoff, the uncultivated plots also continued to be highly erodible after large soil losses.

In addition to the reduced erosion, the cultivated treatments produced a higher corn yield due to increased infiltra-

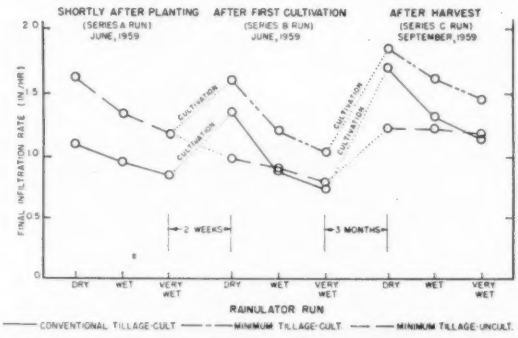

Fig. 5 Final infiltration rates for cultivated conventional tillage, cultivated minimum tillage, and uncultivated minimum tillage of rainulator runs during 1959. Final infiltration rates are the average rates during the last five minutes of each run

tion, reduced competition from other growth, and possibly increased aeration.

A sweep-type cultivator has the undesirable features of loosening much more soil than is necessary to break a surface crust and of leveling the soil surface. From an erosion-control standpoint, a preferable method of cultivation would eliminate the surface crust but would also preserve the rough configuration of the soil surface.

Use of Results

The rainulator results which have been presented indicate the relation of minimum tillage to conventional tillage and the value of cultivation of a crusted soil surface from a soil and water conservation viewpoint. However, the soil losses from all treatments were high. The treatments were applied up and down a 4½ to 5 percent slope, and more than 5 in. of simulated rainfall were applied in a total period of 2 hr during each of three series of runs. This is more intense rainfall than occurs in an average year. However, large intense storms cause the most serious soil losses and are the type of storms for which protection from erosion is most important. Although predictions of average annual losses based upon such storms cannot be made with the accuracy of long-term studies with natural rainfall, the reported results provide useful information on the relative protection from erosion afforded by the various tillage conditions studied.

Adaptation of the results to slope lengths other than the 35-ft plot length and to include factors for mechanical practices may be done by standard procedures (1, 13, 16).

CONCLUSIONS

The results from the reported research are summarized in Table 1, 2, and 3 and Figs. 4 and 5. The following conclusions are based on the more significant information found therein:

Minimum tillage with cultivation very significantly increased the amount and rate of infiltration and decreased the soil loss as compared to conventional tillage with cultivation. The reduced soil loss for minimum tillage during the initial year after meadow is largely attributed to the reduced runoff resulting from increased infiltration.

No important differences in infiltration and soil loss were found among the three types of minimum tillage studied during the initial year.

Elimination of a severe surface crust by cultivation significantly increased the amount and rate of infiltration and decreased the amount of soil loss as compared to no cultivation. Severely crusted soil surfaces continued to erode at high rates.

Soil losses from corn were much less by harvesting time than during the earlier periods of the crop year.

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Seedling Emergence

(Continued from page 71)

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. . . Fence Erecting Machine

(Continued from page 67)

Fig. 4 Where conditions require a two-pass method of fence building, the trailers may be detached from the fence-building machine and the post driver used alone to establish a line of posts in the first pass

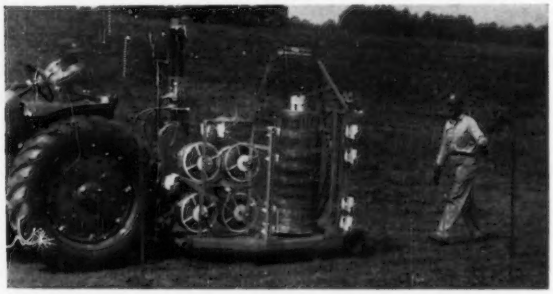

Fig. 5 For the second pass of the two-pass method of erecting fence, the trailer carrying the fence and stretching equipment is mounted to the left side of the drawbar, so the fence may be dispensed and stretched adjacent to the line of posts outside the path of the tractor wheel. (In the one-pass operation the tractor straddles the fence row)

Splicing, usually a time-consuming, difficult job in fence building, has been greatly simplified through the use of special sleeves which, when placed over the ends of the wires to be spliced, are squeezed with a tool and deformed to secure the joint. The technique is particularly advantageous where spaces between wires are so small as to make wire wrapping difficult.

Recovering fence tension after releasing the clamp to drive posts was an expected problem. It turned out to be a a relatively minor one. The steel posts held the tension satisfactorily between machine stretching operations.

Results of Machine Use

As a result of limited tests in 1960, our experience indicates that it should be reasonable to expect this equipment to erect fence two to three times faster than it can be erected manually.

Splicing requires about ten minutes. A single-span end assembly normally requires twenty minutes to install and a single-span corner assembly thirty minutes, from the time the first blow is struck in driving until the fence is ready to attach.

There has been much interest in this machine and its use. Although the machine was built primarily for farm fences, it is adaptable to highway fence erection jobs with the possible substitution of a track-type tractor for the wheel-type machine.

Conclusion

As a result of our experience with the demonstration fence-erection machines thus far, and the reactions encountered, it is believed the concept of mechanical fence erection is sound and certainly long overdue. It is an important agricultural development—one that will enable farmers to lower production costs by fully participating in farming systems to make maximum utilization of land best suited for pasturing or grazing purposes, thus maintaining or increasing profits.

. . . CA Storage

(Continued from page 78)

Methods of Evaluating Adequacy of Design

Heat transfer equipment may be evaluated in terms of its coefficient of performance, the rate at which it brings the product to the desired temperature, and its effect on humidity and atmospheric conditions. The disadvantage of these latter two methods of evaluation is that under normal conditions, they can be made only during actual processing times at some risk to the product.

Mass transfer characteristics of equipment may be evaluated in terms of gross rates of removal or rates of addition of certain constituents to the atmosphere. More highly refined evaluations can be made on the basis of transfer units at given flow rates. These require accurate methods of flow-rate measurements and chemical analysis. Gross permeability tests on CA structures are possible by means of pressure calibration curves and pressure time curves as illustrated in Figs. 5 and 6. Using the results of these tests in a materials balance permits accurate evaluation of the adequacy of the gas seal in CA structures prior to the start of processing.

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Four Elected ASAE Fellows and Eleven to Life Memberships in 1960

The Council of ASAE, during 1960, elected the following members to the grade of Fellow: E. D. Anderson, director, agricultural extension, Stran-Steel Corp.; Nils Berglund, professor, Swedish Institute of Agricultural Engineering; H. F. McColly, professor of agricultural engineering, Michigan State University; and J. W. Simons, leader, farm housing investigations, University of Georgia.

Also elected during 1960 were the following members to the grade of Life Fellow: Henry Giese, professor of agricultural engineering, Iowa State University; F. P. Hanson, formerly agricultural engineer, Caterpillar Tractor Co.; R. E. Hayman, formerly agricultural engineer, Public Service Co. of Oklahoma; H. P. Smith, formerly chief of party Project in Pakistan, A. & M. College of Texas; and F. M. White, formerly director, Gabriel Co.

During 1960 the Council also elected the following members to the grade of Life Member: H. F. Bahmeier, formerly project manager, U.S. Bureau of Reclamation; H. H. Garner, president, Vortex Co.; E. D. Gordon, agricultural engineer, J. I. Case Co.; A. C. Hardison, civil engineer, Santa Paula, Calif.; E. A. Hardy, agricultural engineer, FAO, United Nations, Technical Training Institute, Amparai, Ceylon; and F. L. Rimbach, formerly director of rural development, New England Electric System.

NMSU Agricultural Engineering Curriculum Accredited

Eldon G. Hanson, head of the agricultural engineering department, New Mexico State University, reports that its agricultural engineering curriculum has been accredited by the Engineers Council for Professional Development. The addition of NMSU to the list of institutions whose agricultural engineering curriculums have been duly accredited by ECPD brings the total to 31. Sixteen additional colleges and universities of the United States and Canada offer professional curriculums in agricultural engineering, or their engineering equivalent, and are considered working toward the ECPD standard.

Welcome Indian Agricultural Engineering Society

During a two-day all-Indian Agricultural Engineering Symposium, held last October at the Indian Institute of Technology, Kharagpur, India, an organizational meeting was held formally setting up and approving the constitution for an Indian Agricultural Engineering Society. The forming of this society was a result of the efforts of many individuals over a period of years, including ASAE members Mason Vaugh and Ralph C. Hay, and a number of Indian leaders. Many of the men instrumental in forming the new group are ASAE members who have spent several years in the United States and have attended many ASAE meetings. The society expects to hold an annual meeting, encourage the formation of state or branch sections, publish a quarterly journal, start working on standardization in the production of agricultural implements, and in general build up the profession in the area it serves.

N. D. Agricultural College Now State University

Word has been received from W. J. Promersberger, chairman of agricultural engineering department, North Dakota Agricultural College, that the name of the college has been changed to North Dakota State University. This change became effective on December 8, 1960.

National Science Foundation Summer Institute

The National Science Foundation Summer Institute in Engineering will be held June 26 to August 18 on the campus of the Illinois Institute of Technology. The purpose of this Institute is to make available graduate instruction in fundamental areas of mechanics and applied mathematics to college and junior college teachers who are involved in instruction of basic mechanics courses or related courses. The National Science Foundation has also made available funds so that Institute participants can receive grants of $600 plus dependency and travel allowances. Two courses will be offered — Introduction to the Mechanics of Continuous Media and Analytical and Numerical Methods of Engineering Analysis.

International Conference on the Mechanics of Soil-Vehicle

The first International Conference on the Mechanics of Soil-Vehicle systems will be held June 5 to 9 in the auditorium of the Politecnico, Corso Duca degli Abruzzi, 24, Turin, Italy. The purpose of this conference is to draw the attention of technicians to the various problems related to the soil-vehicle systems in off-the-road locomotion and to promote the dissemination of studies conducted in various countries and particularly in the United States. The subjects to be discussed are divided into the following categories: Review of the State of the Art; Research, Theoretical; Research, Experimental; and New Developments.

Farm Materials Handling Field Days

On March 22 and 23 an extensive display of farm equipment for materials handling may be seen at the Dane County Fair Grounds, Madison, Wis., during the "1961 Farm Materials Handling Field Days." This event, which was held for the first time in 1960, is sponsored by Wisconsin Power and Light Co., Wisconsin Electric Power Co., and Madison Gas and Electric Co., in conjunction with *Successful Farming* Magazine. Sixty-two exhibitors and 22,000 spectators participated in this event last year. For additional information contact: Wayne Russell, rural promotion supervisor, Wisconsin Power and Light Co., Madison, Wis.

Visiting Scientists Lectureship Program

The Society for Industrial and Applied Mathematics has announced the continuation of its Visiting Scientists Lectureship Program for the 1960-61 academic year. This program, which is one of the Society's contributions to the cause of mathematics and its industrial usage throughout the United States, is composed of two complementary phases — each served by a separate panel of visiting scientists. The purposes of the two program phases are: Phase A — Familiarizing college and university groups with mathematical activity in applied and industrial settings; and Phase B — Making available outstanding research mathematicians, active in areas of current interest, to industrial groups for visiting lectures and discussions. A grant from the National Science Foundation supports the Phase A portion of the program which is aimed at colleges and universities. Write to SIAM, 2321 Jameson St., S.E., Washington 21, D.C., for complete information.

Executive Changes at Minneapolis-Moline Co.

New executive changes were announced for the Minneapolis-Moline Co. following the close of its fiscal year on October 28, 1960. Edmund F. Buryan was elected a director and president of the company following the resignation of J. Russell Duncan as president. As chief executive officer, Mr. Buryan is also chairman of the board's executive committee. Prior to his appointment, Mr. Buryan served as vice-president of marketing with W. A. Sheaffer Pen Co. and as a marketing executive with Booz, Allen and Hamilton, management consultants. Other executive changes included the appointment of Stacy L. Angle, who was elected senior vice-president, and Robert A. Trumpis, who was elected vice-president of manufacturing.

A later report on action taken in January revealed that the Board of Directors has voted to recommend to its share holders a change in corporate name to Motec Industries, Inc. The new name is derived from "Moline technology" and was selected because it is said to be symbolic of the company's determination to continue to develop and improve high quality products. The traditional name of Minneapolis-Moline reportedly will continue to be associated with the Farm Equipment Division. The following divisions will be maintained: Minneapolis-Moline Farm Equipment; Mobilift Materials Handling Equipment; Mopower Construction Equipment; Molectronics; Mohawk Foundry and Machine; Moline Automotive; Motec Engineering; Motec International; Mocraft Power Tool; and Pioneer Equipment Finance Co.

EVENTS CALENDAR

February 19-25—*National Engineers' Week.*

February 22-23 — *Seminar on Automation and Numerical Control,* Bond Hotel, Hartford, Conn. Sponsored by the American Society of Tool and Manufacturing Engineers, 10700 Puritan Ave., Detroit 38, Mich.

February 22-23 — *Grain Drying and Storage Conference,* Texas Technological College, Lubbock, Texas. Write to Ira Williams, program chairman, Texas Technological College, Lubbock, Texas, for information.

February 23 — *Engineers, Scientists and Architects Day,* Presidential Arms Hotel, Washington, D.C., sponsored by D. C. Council of Engineering and Architectural Societies.

February 23-24 — *Annual Drainage Conference,* Hanford Hotel, Mason City, Iowa. Sponsored by Mason City Brick and Tile Co., 200 Brick and Tile Building, Mason City, Iowa.

February 27 - March 3 — *Fourth Annual Cooperative Kiln-Drying Short Course,* Purdue University, Lafayette, Ind. Contact Michael O. Hunt, Department of Forestry and Conservation, Purdue University, Lafayette, Ind., for details.

February 28 - March 1 — *Ninth Annual National Dairy Engineering Conference,* Michigan State University, East Lansing, Mich. Contact Carl W. Hall, Agricultural Engineering Dept., MSU, East Lansing, Mich., for additional information.

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F. J. Hassler

H. H. Nuernberger

R. R. Raney

F. J. Hassler recently has been appointed head of the agricultural engineering department, North Carolina State College. A native of Missouri, he was born August 2, 1921, in Cooper Hill. He received a B.S. degree in agricultural engineering in 1946 from the University of Missouri, an M.S. degree in 1948 and a Ph.D. degree in 1950 from Michigan State University. He joined North Carolina State College faculty in 1950 as assistant professor of agricultural engineering for research in tobacco curing. In 1952 he was promoted to associate professor and placed in charge of tobacco curing research, adding the duties of departmental graduate administrator in 1953. In 1954 he was promoted to professor and began teaching electronic instrumentation and advanced thermodynamics for agricultural processing.

As head of a federal-state research team set up to develop bulk tobacco curing, he has been instrumental in bringing about what has been cited as possibly the most important technological advance in tobacco production in the past 100 years. A complete new concept in tobacco curing has been introduced under his direction and it has been reported that in 1961 a large number of insulated steel barns known as "Hassler Bulk Curing Units," will be in operation.

Closely following his appointment as department head, he was awarded an endowed professorship, "William Neal Reynolds Distinguished Professor," an honor which he described as a most appreciated event in his new career.

Howard H. Nuernberger, councilor of ASAE, has been appointed development manager, transportation, for Aluminum Company of America, a newly created position in the development division. Formerly manager of the agricultural section, he now directs the activities of three division sections, charged with furthering the use of aluminum in the automotive, marine, and railroad industries. He has been with the company since 1942.

Russell R. Raney, formerly director of engineering and research for New Idea Farm Equipment Co., recently started dividing his time between acting as a consultant to the company and serving as a teacher and writer in the field of engineering education, particularly in the area of engineering management. The latter part of his plans, rep-

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NECROLOGY

Martin R. Huberty, director of the Water Resources Center, University of California; acting dean of the College of Agriculture, Los Angeles; and professor of engineering, and irrigation and soil science, died suddenly on December 12. He was born May 16, 1894, in Calaveras County, Calif., and while still in his teens taught grammar school for two years. He served in the U.S. armed forces during World War I and received a B.S. degree in irrigation engineering from the University of California in 1920. He was associated with the University of California continuously from 1921 until his death, engaged primarily in research and teaching in the general fields of water resources, irrigation, and drainage. He took a leave from the University in 1933 and 1934 to obtain the professional degree of engineer from Stanford University. During 1951 and 1952, on leave from the University, he served as senior irrigation and drainage officer for the Food and Agriculture Organization of the United Nations in Rome. In this capacity he had supervision over some 20 specialists working in areas throughout the world on problems of water supply engineering, groundwater hydrology, irrigation, and reclamation.

M. R. Huberty

He achieved fame for his professional competence and for his many research accomplishments. Illustrative of his research activities was his pioneer work on soil compaction. He also made notable advances in problems concerned with water requirements of crops, value and cost of water supplies, watershed hydrology, groundwater hydrology, water quality, reclamation, and the effects of various soil management practices on water entry into the soil. In the publishing field, he was senior editor and principal contributor to the book "Natural Resources," and was also a contributor to other books such as "The Citrus Industry," and "California and the Southwest."

He was most active in campus affairs at the University of California, having held the highest office of the Academic Senate and, at the time of his death, he was president of the UCLA Men's Faculty Club, and was also chairman of the University's California Oral History Project Committee.

In addition to being a member of ASAE, he also held memberships in the American Society of Civil Engineers, the Soil Science Society of America, Sigma Xi, American Geophysical Union, and the Western Soil Science Society.

He is survived by his wife, Gertrude, and five children — Richard, Mary Ann Duncan, Alice, Frederick, and Elizabeth Lee.

Julian M. Snyder, vice-president Cunningham & Walsh Inc. Advertising Agency, and account executive for Texaco, Inc., died January 5 at Norwalk Hospital in Connecticut. He was born June 18, 1899, in Elmira, N. Y., and received an A.B. degree from Ohio University in 1922 and an M.B.A. degree from Harvard University Business School in 1928.

J. M. Snyder

Prior to his advertising career, he was a reporter for the Columbus, Ohio, *Citizen* and became Washington correspondent for the United Press. An executive on the Texaco advertising account for the last 20 years, he was a vice-president of Erwin, Wasey & Co. before joining Cunningham & Walsh. His early years at Erwin, Wasey were spent in the agency's London office. During World War II, he was placed in charge of War Bond advertising in rural areas, for which he received the Silver Medal Award from the U.S. Treasury Department.

He had been an ASAE member since 1944. He was active in civic affairs and served as vice-president and director of the Bell Island Improvement Association in his home community of Rowayton, Conn. He is survived by three sons—Julian, Jr., Charles, and Barry—and three daughters—Mrs. Scott F. Ashton, Mrs. Thomas Arouni, and J'Anne Snyder.

James B. Kelley, Life Fellow of ASAE and retired professor of agricultural engineering, University of Kentucky, died Friday, December 23, in Lexington, Ky., after a long illness.

J. B. Kelley

A native of Iowa, he was born in Farley on July 4, 1889. He received a B.S. degree in mechanical engineering in 1912 and a B.S. degree in agricultural engineering in 1913 from Iowa State University. From 1913 to 1919 he was an instructor in agricultural engineering at Iowa State University, and during World War I he served in the U.S. Army. He served as head of the agricultural engineering section of the agronomy department at the University of Kentucky College of Agriculture from 1919 to 1956, when the present department of agricultural engineering was organized. He went on retirement status September 1, 1959.

Professor Kelley had a major part in the design of the present agricultural engineering building at the University of Kentucky,

(Continued on page 96)

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Mississippi Section

T. N. Jones, secretary-treasurer of the newly formed Mississippi Section, reports that a total of 29 have applied for membership since work was started to organize the section.

Iowa Section

The Iowa Section held a buffet dinner meeting on February 8 in the North Room of the Fort Des Moines Hotel in Des Moines, Iowa. It was joined by the Industrial Engineering Society Agricultural Section, National Society of Professional Engineers, who held their 72nd Annual Meeting in Des Moines, Iowa, February 8 through 11. Included on the program following the dinner was a talk by Richard G. Hoft, manager, electric power conversion engineering, General Electric Co., on the importance and benefits of registration by engineers in industry, and a discussion by William L. Brown, geneticist, Pioneer Hi-Bred Seed Corn Co., on observations of Russia's agricultural developments in the world.

Quad City Section

The Quad City Section held a joint dinner meeting with ASME on January 13 at the American Legion Hall, Moline, Ill., with 277 in attendance. L. S. Kellogg, an economist with Deere & Co. and one of two featured speakers, presented some revealing information concerning the future of the industries related to the nation's agriculture when he addressed the group on nostalgia, agriculture, and agricultural engineering. The other featured speaker, W. M. Cade, divisional chief engineer, test and development group, International Harvester Co., gave an interesting insight to the work done at the company's Hinsdale Research and Engineering Center. This icluded an initial presentation of a film entitled "Creating Time Through Test Engineering." Special guests for the evening included: Bengt Henslow, son of a Swedish farmer, who is in our country for one year to learn about our farming and machinery; Boris Runov, a teacher at the Engineering Academy in Moscow, Russia, who is currently on a visit to Iowa State University; and Lloyd Bixby and William Lampham, two Canadians, who are graduates of Iowa State University.

The Quad City Section conducted its annual Technical Series meetings on January 26, February 2 and 9, at the Iowa-Illinois Gas and Electric Co. Auditorium in Rock Island, Ill.

Hydraulic components and their use in mobile machinery systems were discussed by Thomas M. Heroux, field engineer, Denison Engineering Division of American Brake Shoe Co. at the January 26 meeting. This discussion covered the type of systems commonly used in agricultural and construction machinery today, and the components included pumps, valves, fluid motors, cylinders, and their arrangement in the hydraulic circuit. John A. Noel, marketing and development, Plastics Division of DuPont, covered the subject of plastics available for industry during the February 2 meeting. This discussion included the growth of the plastics industry and the development of plastics for both industrial and agricultural applications. The third and last meeting, held on February 9, was a panel type discussion on the subject of the tool engineers' role in agricultural engineering. The subject was divided into the following topics for discussion: Design of parts for manufacture; tolerances for assembly and function; alternate tooling methods; and tolerances that are misunderstood. Members of the panel included: C. K. Beeman, product engineer, J. I. Case Co.; W. D. Gibbons, production research engineer, International Harvester Co.; and Carl Krauel, master mechanic, John Deere Spreader Works.

Chicago Section

The Chicago Section held a 6:00 p.m. dinner meeting on February 6 at the Palmer House, Chicago. The program which followed the dinner included presentations on wafering, by Dale O. Hull, extension agricultural engineer, Iowa State University, and pelleting, by Roy Robinson of California Pellet Mill Co., Crawfordsville, Ind.

Pacific Coast Section

The Pacific Coast Section has launched its new organizational plan which subdivides the Section into three Chapter areas — Northern California-Western Nevada, Southern California, and Arizona. All of the Chapters have held their first meeting with a good attendance at each one and have elected the following officers: Northern California-Western Nevada Chapter—E. P. Speck, chairman; W. O. Pruitt, vice-chairman; and W. C. Fairbank, secretary-treasurer; Southern California Chapter — R. L. Perry, chairman; W. A. Hall, vice-chairman; and A. F. Klinge, secretary-treasurer; Arizona Chapter — A. D. Halderman, chairman; R. E. Moore, vice-chairman, and C. D. Owens, secretary-treasurer.

ASAE MEETINGS CALENDAR

February 23 — WASHINGTON, D. C. - MARYLAND SECTION, USDA South Building, Washington, D. C.

February 25—MICHIGAN SECTION, Hudson's Northland, Detroit, Mich.

March 30-31 — PACIFIC COAST SECTION, Davis, Calif., area.

April 7-8 — MID-CENTRAL SECTION, St. Joseph, Mo.

April 14-15 — ROCKY MOUNTAIN SECTION, University of Wyoming, Laramie.

April 14-15 — SOUTHWEST SECTION, Grim Hotel, Texarkana, Texas.

June 25-28—ANNUAL MEETING, Iowa State University, Ames, Ia.

August 20-23—NORTH ATLANTIC SECTION, University of New Brunswick, Fredericton, N. B., Canada.

December 13-15 — WINTER MEETING, Palmer House, Chicago, Ill.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Washington, D. C. - Maryland Section

The Washington, D.C. - Maryland Section held its monthly luncheon meeting on January 13 in the USDA South Building, Washington, D. C. T. E. Hienton, chief, farm electrification section, AERD, ARS, USDA, gave a report and showed color slides of his recent three-week study tour of rural electrification in the United Kingdom and Ireland. Details for the tour were arranged by the Ministry of Power and the Electricity Council of the United Kingdom and the Electricity Supply Board of Ireland, and included stops in England, Wales, Scotland, and Ireland.

The next Section meeting also will be held in the USDA South Building on February 10. The speaker at this luncheon meeting will be R. G. Yeck, chief, Livestock Engineering and Farm Structures Research Branch, AERD, ARS, USDA. He will report on and show slides of his recent visit to Great Britain when he speaks on "Observations of Recent Farm Structures-Developments in Great Britain."

The Section secretary-treasurer, John W. Rockey, reports that arrangements are being made to seat the Section at ASAE tables for the luncheon to be held during Engi-

(Continued on page 102)

The Pacific Northwest Section installed new officers for the year 1960-61 at its annual meeting held October 21, at the Empress Hotel, Victoria, B. C., Canada. Shown above is R. S. Tait *(right)*, retiring section chairman, passing gavel to C. H. Pair, new secretary-treasurer, who accepted in behalf of L. R. Swarner, new chairman. At right, Dean Booster *(left)* reported for the Student Affairs and Awards Committee. He is shown presenting the second prize student paper award to John Guitjens, University of British Columbia

The following bulletins have been released recently. Copies may be obtained by writing to author or institution listed with each.

The following may be obtained from Canterbury Agricultural College, Lincoln College, Christchurch, New Zealand.

Aircraft in Agriculture by G. G. Lindsay. Bulletin No. 348. July, 1958.

Tractor Power and Performance by G. O. Lindsay. Bulletin No. 352. November 1958.

A Survey of Machinery and Methods for Fodder Conservation by G. G. Lindsay. Reprint from Proceedings of Lincoln College Farmers' Conference, 1960.

American Standard—Metallizing Symbols. ASA Y32.12-1960. The American Society of Mechanical Engineers, 29 West 39th St., New York 18, New York.

Foreign Competition—A Challenge for America. Study prepared under the supervision of the Economic Advisory Committee, National Association of Manufacturers, which is made up of a cross section of 27 businessmen from various sections of the United States. NAM, 2 E. 48th St., New York 17, New York.

The following bulletins may be obtained from the University of Kentucky, Cooperative Extension Service, Lexington, Ky.

Regulatory Bulletin 150, *Commercial Fertilizers in Kentucky, 1959.* July-December, 1959.

Circular 508-A, *The Home Fruit Garden* by Carl E. Chaplin.

Filing Code 24-2-1, *Results of Research in 1959.*

The following test reports may be obtained from the British Society for Research in Agricultural Engineering, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, England.

No. 259 *G. & R. Junior Mk. III Pyrethrum Drier.* August 22, 1960.

No. 260/BS *Massey-Ferguson Model FE-35 Diesel Tractor with 3.A 152 3-cylinder engine.* March 1960.

No. 261 *Kidd Rotaflail Offset Model Forage Harvester,* October 26, 1960.

No. 262/BS *International Model B-275 Diesel Tractor.* June/July 1960.

No. 263 (East Africa) *Steyr Model T.84 Diesel Tractor.* September 1960.

No. 264 *Trojan Balemaster Loader and Gale Bale Sledge.* November 1960.

No. 265 *"Gloster" Forage Harvester (Type H2; 40 in., offset rear-delivery model).* November 1960.

A Bibliography of Farm Buildings Research, 1945-1958. Part IV Buildings for Cattle. Available from Agricultural Research Council, 15 Regent St., London, S. W. 1, England. Price, 4s. 11d.

An Assessment of Investments in Land Reclamation. Publication—7. A Study from the Point of View of the National Economy. International Institute for Land Reclamation and Improvement, P.O. Box 45, Wageningen, Holland. Price $1.50.

Local Administration of Water Control in a Number of European Countries. Publication—8 by Prof. F. Hellinga. A Study from the Point of View of the National Economy. International Institute for Land Reclamation and Improvement, P.O. Box 45, Wageningen, Holland. Price $1.00.

Electric Motors and Controls, by D. W. Works and J. W. Martin. Farm Electrification Leaflet No. 51. College of Agriculture, University of Idaho, Moscow, Idaho.

Agricultural Machinery Workshops: Design, Equipment and Management. FAO Agricultural Development Paper No. 66. 1960. Distribution and Sales Section, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, Rome, Italy.

Second Annual Report of the Director of the Agricultural Machinery Administration and the Chairman of the Agricultural Machinery Board. 12 months ended March 31, 1960. Department of Agriculture, Government of the Province of Saskatchewan, Regina, Saskatchewan, Canada.

How Effective Are Hay Conditioners? by T. W. Casselman and Robert C. Fincham. Reprint from Nov.-Dec. 1960 issue of *Iowa Farm Science.* College of Agriculture, Iowa State University, Ames, Iowa.

Engineering Professionalism in Industry. Survey report for The Professional Engineers Conference Board for Industry in cooperation with the NSPE. National Society of Professional Engineers, 2029 K St., N.W., Washington, D.C. Price, $4.00.

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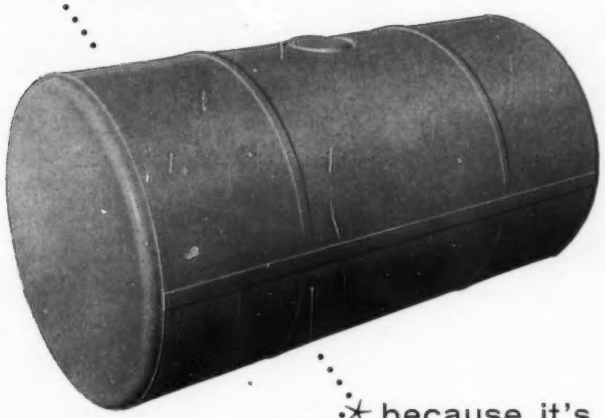

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RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural-engineering interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

USDA Sponsors Symposium on Poultry Health

A symposium on poultry health and related problems will be sponsored by the U.S. Department of Agriculture at the Center for Continuing Education at the University of Georgia, Athens, March 20-22.

The program is being planned primarily for research workers and scientists concerned with poultry problems in both public agencies and industry.

This symposium will consider disease, environmental, and management factors related to poultry health. Practical means of overcoming current difficulties in the poultry industry through joint action by scientists, State and Federal regulatory workers, and poultry producers and processors will be discussed.

The symposium is being convened in the Southeast in recognition of the growing importance of this area in production of both eggs and poultry meat.

USDA efforts to solve poultry health problems will be intensified in two new poultry research laboratories planned for this region. One of these laboratories will be located at Athens, and the other at State College, Miss. Each will be staffed with veterinarians, agricultural engineers, and poultry husbandmen, working together as a team to improve poultry health through research.

Details concerning this symposium will be made available to State Experiment Stations. Additional information may be obtained from the Agricultural Engineering Research Division, Beltsville, Md.

New Leaflet on Problems in Cotton Quality Released by USDA

A new publication, "Cotton Quality Problems Associated with Mechanical Harvesting," has been released by USDA. This leaflet describes the problems caused by the use of mechanical harvesting of cotton and explains what techniques and equipment have been developed to reduce these drawbacks, as well as discussing current work and future possibilities.

New Publication Cites Harvesting Problems

The harvest and handling of grapes and procedures of receiving them at several Michigan grape processing plants are evaluated on the basis of labor requirements, costs, and the effect on product quality in a new USDA publication. "A Progress Report on Harvesting and Handling of Concord Grapes" is based on the first two years of a study conducted by ARS and Michigan State University agricultural engineers.

ARS Engineer Assists Rockefeller Foundation in Colombia

William A. Bailey of the Livestock Engineering and Farm Structures Research Branch, AERD, USDA, is in Bogota, Colombia, serving as a consultant for the Rockefeller Foundation on the operation and maintenance of plant growth chambers.

Bailey recently began exploratory research to develop improved designs for these chambers in cooperation with the ARS Crops Research Division. Growth chambers provide a controlled environment for plant growth studies.

Two USDA Engineers Attend White House Conference

J. W. Simons, Athens, Ga., leader of farm housing investigations, Livestock Engineering and Farm Structures Research Branch, AERD, ARS, USDA, and W. R. Parker, Beltsville, Md., architect for farm housing investigations, attended the White House Conference on the Aging held in Washington, D. C., January 9 to 12. As observers at the Housing Section meetings, they noted recommendations and suggestions helpful in planning future farm housing research and in developing farmhouse plans for aging farmers and ranchers.

New Publications Available on Saw and Toothed Cotton Ginning

A limited number of copies of "Saw and Toothed Cotton Developments," a new publication by Charles A. Bennett, Cotton Ginning Section, AERD, ARS, USDA, at Stoneville, Miss., is available through the AERD Harvesting and Farm Processing Research Branch, at Beltsville, Md.

The publication, which includes 90 pictures and illustrations, discusses the historical development of saw and toothed gin use and design in the U.S. since the invention of the cotton gin.

. . . Events Calendar

(Continued from page 89)

March 2-7 — *International Technical Congress of Agricultural Machinery,* Paris, France. For information write to: Congres International Technique du Machinisme Agricole, 19, Rue Jacques Bingen, Paris XVII, France.

March 5-9 — *Sixth Annual Gas Turbine Conference and Products Show,* Shoreham Hotel, Washington, D. C. Sponsored jointly by the Gas Turbine Power Division, The American Society of Mechanical Engineers, and the U. S. Department of Defense. For details contact ASME, 29 W. 39th St., New York 18, N. Y.

March 7-12—*32nd International Machinery Show,* Paris, France. For additional details write to Robert de Wilde, agricultural attache, 1001 Connecticut Ave., N.W., Washington 6, D.C.

March 9-10 — *Annual Meeting, Dairy Industries Supply Association,* Barbizon Plaza Hotel, New York City. Information may be obtained from: DISA, 1145 19th St., N.W., Washington 6, D. C.

March 16-17 — *1961 Textile Engineering Conference,* Clemson College, Clemson, S.C. Information may be obtained from The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

March 22-23 — *Farm Materials Handling Field Days,* sponsored by Wisconsin Power and Light Co., Wisconsin Electric Power Co., and Madison Gas and Electric Co., in conjunction with Successful Farming Magazine. For additional information contact Wayne Russell, rural promotion supervisor, Wisconsin Power and Light Co., Madison, Wis.

March 28-29 — *Fifth Transportation of Perishables Conference,* University of California, Davis. For information write to: Agricultural Extension Information, Division of Agricultural Sciences, University of California, Davis.

April 15-25 — *1961 Swiss Industries Fair,* Basle, Switzerland. Details may be obtained from Consulate General of Switzerland, 75 E. Wacker Dr., Chicago 1, Ill.

April 17-19 — Eighth *National Watershed Congress,* Ramada Inn, Tucson, Ariz. Details may be obtained from The National Association of Soil Conservation Districts, League City, Texas.

April 17-21 — *American Welding Society 42nd Annual Convention,* Commodore Hotel, 42nd St., New York, N. Y. For further details write to Information Center, AWS, 33 W. 39th St., New York 18, N. Y.

April 18-20 — *North Central Regional Extension Agricultural Engineers' Workshop,* Del Prado Hotel, Chicago, Ill. For information write to Arthur H. Schulz, Extension Service, North Dakota University, Fargo, N. D.

April 20-22 — *76th Annual Convention of the Illinois Society of Professional Engineers,* Peoria, Ill. Information may be obtained from ISPE, 1108 East London Ave., Peoria, Ill.

May 2-4 — *Purdue Industrial Waste Conference,* Purdue Memorial Center, Purdue University, Lafayette, Ind. Further details may be obtained from D. E. Bloodgood, conference chairman, Purdue University, Lafayette, Ind.

May 7-10 — *American Feed Manufacturers Convention* and *National Feed Industry Show,* Conrad Hilton Hotel, Chicago, Ill. Particulars may be obtained by writing to E. H. Roesler, editor and publisher, The Feed Bag, 1712 W. St. Paul Ave., Milwaukee 3, Wis.

May 22-25 — *Design Engineering Show,* Cobo Hall, Detroit, Mich. Information may be obtained from: Clapp and Poliak, Inc., 341 Madison Ave., New York 17, N. Y.

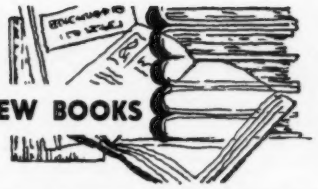
June — *First International Conference on the Mechanics of Soil-Vehicle Systems,* Turin, Italy. For further information write to: M. G. Bekker, national secretary for the Conference, U.S. Army Ordnance Tank-Automotive Command, 1501 Beard, Detroit 9, Mich.

June 9-17 — *European Congress of Chemical Engineering and ACHEMA Congress,* Frankfurt am Main. Information is available from DECHEMA, Frankfurt am Main 7, Postfach.

June 11-15 — *American Society of Mechanical Engineers Summer Annual Meeting,* Statler-Hilton Hotel, Los Angeles, Calif. Contact ASME headquarters, 29 W. 39th St., New York 18, N. Y., for information.

June 11-23 — *Solid State Mechanics Short Course,* The Pennsylvania State University, University Park, Pa. Further information may be obtained from Conference Center, Pennsylvania State University, University Park, Pa.

June 25-30 — *American Society for Testing Materials Annual Meeting,* Chalfonte-Haddon Hall, Atlantic City, N. J. Write to ASTM headquarters, 1916 Race St., Philadelphia 3, Pa., for information.



Marketing Poultry Products — Fifth Edition, by Earl W. Benjamin, Fred L. Faber, James M. Gwin, and William D. Termoblen. Cloth. 6 x 9½ in. xi + 327 pages. Illustrated and indexed. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. $7.75.

In this fifth edition the authors have tried to bring the students and other readers abreast of the changes that have taken place in the egg and poultry marketing field. Included in the new features are: More material on the economics of marketing than previous editions; greater prominence to the preparation and marketing of the by-products of both poultry and eggs; descriptions of all important new methods of materials handling, distribution and merchandising; the use of automation in the various phases of egg- and poultry-handling; discussions of the technical innovations, as well as major changes in the structure and organization of the marketing system; sets of review questions, supplementary reading lists, and a selective bibliography.

Hutte, Des Ingenieurs Taschenbuch, by Teil B. Maschinenbau. 28th edition, 1960. 930 pages. Illustrated. Published by Wilhelm Ernst Sohn, Berlin.

The Hutte series of "Engineers' Companion Books" is intended as a general reference handbook for engineers. The material is presented so that practicing and research engineers can acquaint themselves with information, development, and experiences, not only in their own fields of specialization, but also in other fields with which they have no daily contact. Of most interest to agricultural engineers will be the sections on tractors and refrigeration. The section on tractors covers 80 pages with 85 illustrations and numerous references. The section should "give a general picture of tractor progress in West Germany and should supply valuable information and experiences for use by manufacturers, instructors and students." Among the aspects covered in the Tractor Section are: Speed and power requirements, engines, tractor types, drive mechanisms, locomotion, tires, soil pressures, auxiliary equipment, hitches, hydraulic systems, costs, and normalization. Reviewed by Herman Bouwer, agricultural engineer, Western Soil and Water Management Research Branch, Soil and Water Conservation Research Division, ARS, USDA, Southwest Water Conservation Laboratory, Tempe, Ariz.

Tuinbouw Techniek 1959-60. 304 pages. Illustrated. Published by Institute of Horticultural Engineering, Wageningen (Holland).

This book, of which a descriptive title could well be "The 1959-60 book of new ideas in horticultural engineering," is divided into eight sections covering a total of approximately 110 items. The sections are: Greenhouse construction; air and temperature control; use of electricity in horticultural practices; tractors and machinery; spraying and sprinkling; harvesting and sorting; labor methods and efficiency; and miscellaneous. A great variety of topics is included, such as new ideas for greenhouse construction, use of plastics, salt water

(Continued on page 102)

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. . . ASAE Members in the News

(Continued from page 90)

resenting entry of one of the farm equipment industry's engineering experts into the teaching of engineering management after 26 years of actual experience, is believed to be unique in the industry. He received a B.S. degree in mechanical engineering in 1934 from the University of Michigan and an M.S. degree in business administration in 1948 from the University of Chicago. Prior to joining New Idea in 1955, he was assistant manager of engineering for the Farm Implement Division, International Harvester Co.

Peter K. Bourbeau has been appointed a district representative for the International Division of Hyster Co. His district covers the southern half of the African Continent. He previously was a field engineer with Caterpillar Overseas C. A.

A. A. Swamy Rao, formerly a product engineer at John Deere Harvester Works, Moline, Ill., is now working as a research engineer for John Deere Intercontinental, S. A., in India.

Ray M. Lien, agricultural engineer, Purdue University, has been named chief of party of the Purdue-Brazil project. He went to Brazil, South America, in 1958, as the agricultural technician with the Purdue-Brazil University educational training program. The party is located at a rural university about 250 miles north of Rio de Janeiro.

William G. Searles, formerly chief engineer for Interurban Industries Division of Union Fork and Hoe Co., Indianapolis, Ind., has given up engineering to enter the ministry. He is now the pastor of The Reorganized Church of Jesus Christ of Latter Day Saints, Louisville, Ky. He was ordained to the ministry in 1948 after special study prescribed by the church, which has no seminaries as such. Until he came to Louisville and while working for Interurban Industries he had given of his free time to part-time pastorates.

Peter A. Boving has joined the agricultural engineering staff of the University of Illinois as an assistant professor, with primary responsibilties in the area of soil and water extension. He previously was associated with Capico, Inc. in Lindsay, Calif.

Pierre J. Jutras has accepted a position as project engineer with the Speed Sprayer Plant of the John Bean Division of Food Machinery and Chemical Corp., Orlando, Fla. He previously was assistant agricultural engineer at the University of Florida, Citrus Experiment Station, Lake Alfred, Fla.

Ted Zorich an ASAE student member and an agricultural engineering senior at Colorado State University, has been selected to this year's edition of "Who's Who Among Students in American Universities and Colleges." The nomination, one of the highest honors a college student can receive, is based on the individual's scholarship, participation and leadership in academic and extracurricular activities, citizenship and service to the school, and promise of future achievement.

William J. Teaford has joined the agricultural engineering staff at the University of Illinois on a part time basis. He previously held the position of design engineer at the Farm Equipment Engineering Research Center, International Harvester Co., Hinsdale, Ill.

George H. Hargreaves has been transferred from his ICA position as an irrigation engineer in Manila, The Philippines, to one in Rio de Janeiro, Brazil, where he is also an irrigation engineer.

James A. Miller, director of engineering, Minneapolis-Moline Co., has been selected to serve on a six-man operating committee, to coordinate activities of the company to obtain the greatest possible logistical efficiency from all operations in order to sustain and support the marketing effort, to communicate the recommendations of the committee and the decisions of the president to all areas of the organization, and to serve as advisor to the president with respect to policy matters.

Ralph H. Allee, long-time director of the Inter-American Institute of Agricultural Sciences in Costa Rica, has accepted a position as associate on community development for the Council on Economic and Cultural Affairs in New York City.

Vernon L. Anderson has been transferred to a new position with the Bureau of Reclamation — that of branch engineer and assistant irrigation manager for the Franklin Field Branch, Irrigation Division, Columbia Basin Project at Mesa, Wash. He was formely a hydraulic engineer for the Bureau.

David H. Bucher, formerly a research engineer with Caterpillar Tractor Co., is now a research assistant at Pennsylvania State University.

W. L. Denniston, formerly associated with Rogers Publishing Co., has accepted a position as sales manager with the EMI Electronic Products, Fairbanks, Morse & Co., West Hartford, Conn.

Lauren W. Gates is now located in Lodi, Calif., where he is employed as project engineer with the Blackwelder Mfg. Co. He was previously a designer with New Holland Machine Division of The Sperry Rand Corp., New Holland, Pa.

James G. Harter, has accepted the position of planning engineer with Sandia Corp., Livermore, Calif. He previously was employed by American Machinery Corp. as a sales engineer.

Jack Keller, who has been chief hydraulic engineer for W. R. Ames Co., has joined the staff at Utah State University as an assistant professor.

L. A. McCunn advises that he is now located in Waterloo, Iowa, where he is an engineering trainee with John Deere Tractor Research and Eng. Center. He previously was farm electrification engineer for Wisconsin Electric Power Co.

Melvin A. Hagood, having completed his graduate study and received an M.S. degree in irrigation science at the University of California, has returned to the extension service at Washington State University as acting extension agricultural engineering specialist for the Prosser Irrigation Experiment Station.

Robert L. McFall has joined the agricultural engineering department staff at the University of Illinois, where he is an instructor in soil and water. He was formerly an assistant engineer for the Water Resources Division, State of Kansas.

Stephen J. Mech has been transferred from the Prosser, Wash., office of the USDA Agricultural Research Service to its Fort Collins, Colo., office, where he is a research investigations leader for erosion control.

John Monteith, III has accepted a position of highway engineer with the USDA Forest Service. He was formerly an agricultural engineer with the USDA Soil Conservation Service.

Robert R. Rowe, formerly manager of the Doane Agricultural Service, St. Louis, Mo., is now associated with the Market Development Division of U.S. Steel Corp. as a market development representative.

Robert M. Smith has accepted a position as sales representative for Metal Products Section, Motor Wheel Corp., Lansing, Mich. He formerly was a product design engineer in the implement engineering dept., Tractor and Implement Division, Ford Motor Co., Birmingham, Mich.

Russell T. Snow has accepted the position of assistant drain engineer for the Macomb County Drain Commission, Mt. Clemens, Mich. He previously was connected with the USDA Soil Conservation Service, as an agricultural engineer.

George E. Williams, who was associated with B and G Drilling and Supply, as well as M and G Equipment, as an agricultural engineer, has accepted a position with Tipton and Kalmbach Inc. of Denver, Colo. He is located in Lahore, Pakistan, working on an irrigation and reclamation project. The work is of a technical and supervisory nature in connection with the construction of some 1800 tubewells.

. . . Necrology

(Continued from page 90)

which was erected in 1931. This building was named Kelley Hall in his honor in 1959. He taught college students, vocational agriculture and veteran-teachers, farm leaders and farmers for 45 years; was administrator in charge of all teaching, research and extension programs in agricultural engineering carried on in Kentucky for 37 years; acted as consultant to the Kentucky Agricultural Experiment Station farms in design and construction of major buildings, roads, drainage, water and sewage disposal systems; acted as consultant for most of the state's 4-H Club county and regional camps; and was consultant and supervisor of all maintenance work on structures, land, soil and water systems of the Experiment Station Farm from 1919 to 1955.

During his tenure at the University of Kentucky, he was a consultant to the Soil Conservation Service and a member of the Advisory Committee in Soil Erosion Investigations; a collaborator with the United States Bureau of Home Economics and Agricultural Engineering in making a rural and farm housing survey; a member of the Mid-West Building Plan Committee; a director of the In-Service Training Program for 29 rural electric cooperatives; and founder of the Kentucky Inter-Industry Farm Electrification Council.

His membership in ASAE dates back to 1913 and he was a charter member of the first student branch at Iowa State University in 1910. He was elected a Life Member in 1949 and a Fellow in 1959. He was a member of the American Association of University Professors, Alpha Zeta, and Gamma Sigma Delta.

His survivors include his wife, Alice, and two daughters, Mrs. Kenneth J. Woodruff and Mrs. George A. Cannon.

MANUFACTURERS' LITERATURE

Literature listed below may be obtained by writing the manufacturer.

Fluid Power Equipment

Hydreco Division, The New York Air Brake Co., 9000 E. Michigan Ave., Kalamazoo, Mich. — An 8-page general bulletin, No. 10-001, describes and illustrates gear pumps, control valves, and motors, and their application on mobile equipment and production machinery. The construction and design features of each of the various components are described in detail and illustrated with photographs and cutaway drawings.

Bulk Material Handling Booklet

Tote System, Inc., Beatrice, Nebr. — Catalog No. 8, a 32-page booklet, details all the ramifications of a complete bulk material handling system as an inplant and interplant system; automated system; distinct storage units; and discharge hoppers and shipping containers. Photos and diagrams show system in operation and also show special applications and adaptations of both liquid and dry materials handling bins.

Heat Transfer Equipment

Young Radiator Co., Racine, Wis. — A 32-page, 3-color catalog, No. 160, covers heat exchangers, supercharger air coolers, industrial and oil field equipment, and heating and air conditioning products. Information includes a brief history of the company, its location, facilities, and services, and a complete product resume, including installation photos. A presentation of scientific nuclear heat transfer applications, stressing technical research developments to meet the requirements of the atomic era, complete the contents.

Fireproofing Publications

Vermiculite Institute, 208 S. LaSalle St., Chicago 4, Ill. — Several recent publications covering vermiculite concrete, water repellent masonry fill insulation, and specifications and technical data on type MK fireproofing are offered.

Switches for Industry

Micro Switch, a Division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. — Form No. 84-441, a 4-page circular entitled "Switches for Industry," features adjustable pulse, center neutral limit and proximity switches. Illustrated are a variety of limit, explosion-proof, basic, pushbutton, mercury, and toggle switches for use on machine tools and other industrial equipment.

Belting Catalog

The Boston Woven Hose & Rubber Division, American Biltrite Rubber Co., Boston 3, Mass. — A 36-page belting catalog gives complete specifications and information on full line of conveyor, elevator, and transmission belting. In addition to the detailed data, cross-section illustrations show the construction of each belt. One section is devoted to helpful tables dealing with belt eights, belt gages, fabrics, and belt recommendations. Another section deals with the company's technological advancements.

Automotic Transmission for Small Engines

Morse Chain Co., a Borg-Warner Industry, Ithaca, N. Y. — Product Catalog No. PFT-60, an 8-page, 2-color piece, describes and illustrates an automatic power-flow transmission for engines 1 to 25 hp, including general information, applications, principle of operation, drive selection chart, installation data (with diagrams), and maintenance tips.

Pumping and Hydraulic Data Manual

Peerless Pump — Hydrodynamics Division, Food Machinery and Chemical Corp., 301 West Avenue 26, Los Angeles 31, Calif. — A 20-page manual, designated as Bulletin EM-77 and entitled "Useful Pumping and Hydraulic Engineering Data," emphasizes practical data for the engineers' everyday use, and includes charts and problem solving formulae. Other informative reference items are also given, including a weir table, orifice charts of pipe and friction loss charts.

Tractor Literature

Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. — The following literature pieces are offered:

Catalog UT-130 describes and illustrates the utility applications of two industrial crawler tractors — the H-3 gasoline powered model and the HD-3 diesel powered unit.

Two catalogs — No. TL-2332, covering the D-15 three-plow tractor, and No. TL-2334, covering the D-17 four-plow tractor — describe and illustrate each tractor feature. Specifications are also included.

Farmers Reference Handbook

Behlen Manufacturing Co., Columbus, Nebr. — A 32-page booklet, the 1961 edition of the Farmers Handbook is entitled "You . . . and On-the-Farm Grain Storage." This handbook reviews ASC and CCC regulations for grain storage on the farm and also includes suitable illustrations.

Corporate Booklet

Rockwell-Standard Corp., Coraopolis, Pa. — A 36-page, 2-color bookle entitled "Dynamic . . . Diversified" contains information concerning the products, corporate organization, and foreign operations of the firm, including illustrations.

Clutch Plates and Facings

The S. K. Wellman Co., 200 Egbert Rd., Bedford, Ohio — Bulletins Nos. S-55-30 and L-1391A contain data on Velvetouch and Velvetouch Feramic clutch plates and facings for agricultural machinery.

Mulch Treader

Richardson Manufacturing Co., Cawker City, Kans. — A 16-page brochure describes and illustrates the mulch treader for use in stubble mulch farming or crop residue management. Construction features are also included.

Soil Testing Equipment

Irrigation Engineering Corp., 335 Genoa St., Monrovia, Calif.—Two catalogs describe and illustrate pressure membrane, porous plate, and filter funnel apparatus for use in the soils laboratory, and tensiometer type moisture gages for the laboratory, experimental farms, commercial grower, greenhouse, home garden and potted plants.

Engineering Manual

Marlow Pumps, Division of Bell & Gossett Co., P.O. Box 200, Midland Park, N. J. —Engineering Manual No. EM-60 contains 24 pages of indexed information, charts, and graphs regarding pump selection, installation, and application.

Hydrostatic Transmissions

Dynex Inc., 777 Dynex Dr., Pewaukee, Wis. — A 17-page, mimeographed, illustrated technical paper entitled "Hydrostatic Transmissions" presented at a recent conference on hydrostatic transmissions.

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Address.....

City.....State.....

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

A-Rahman, Tag E. D. — Trainee, (SCS) USDA. (Mail) c/o Loyd M. Adcock, FAS-FTD, USDA, Washington 25, D.C.

Atkins, Richard C. — Specification exec., Massey-Ferguson (U.K.) Ltd., Banner Lane, Coventry, England

Bauer, Jr., Charles A. — Materials handling spec., Charles H. Hood Dairy Foundation, 500 Rutherford Ave., Boston 29, Mass.

Bedri, Mohd A.—Agr. engr., eng. div., dept. of agr., Ministry of Agr., Khartoum, Sudan

Brian, Gerald A. — Sales spec., Koppers Co., Inc. (Mail) 1596 Buttrick Ave., S.E., Ada, Mich.

Cabotaje, Amante P. — Instr., Mindanao Institute of Technology, Kabacan, Cotabato, Philippines

Howell, William D. — Irrigation engr., Choctaw, Inc. (Mail) 1381 Oakwood Dr., Whitehaven, Tenn.

Hubbard, Roy C. — Agr. engr., (SCS) USDA, P.O. Box 1128, Grenada, Miss.

Kawamura, Setsuji — Des. engr., exp. sta., Hawaiian Sugar Planters Assn., 1527 Keeaumoku St., Honolulu 14, Hawaii

Kuether, Donald O. — Eng. trainee, tractor eng. dept., Allis-Chalmers Mfg. Co. (Mail) 6207 W. Oklahoma Ave., Milwaukee 19, Wis.

Moore, Julian S., Jr. — Student, agr. eng. dept., University of Florida. (Mail) 820 N.W. 20th Terr., Gainesville, Fla.

Ray, Kermit R. — Asst. ext. agr. engr., agr. ext. service, Mississippi State University, State College, Miss.

Rist, Paul R. — Construction engr., (SCS) USDA. (Mail) 210 E. Maple St., Beresford, S. D.

Snyder, Alfred A. — 110 S. Tulpehocken St., Pine Grove, Pa.

Stokely, Theodore P. — Serviceman, farm equipment sales, International Harvester Co. (Mail) 2743 Amelia Ave., Decatur, Ga.

Suddarth, Stanley K. — Professor, Dept. of Forestry and Conserv., Purdue University, Lafayette, Ind.

Swain, Paul E. — Plant engr., Big Chief Div., Consumers Co-op. Assn. (Mail) 3013 N. Elm, Hutchinson, Kans.

Tanaka, Takashi — Asst. prof. of agr. machinery, agr. eng. section, Shiga Prefectural College, Kusatsu, Shigaken, Japan

Thomas, Lacy G., Jr. — Pres. and mgr., Thomas Tractor Co., 1620 N. Magnolia, Oscala, Fla.

Tisdale, Robert L. — Agr. engr., (SCS) USDA. (Mail) 919 W. Lynne, Greenville, Miss.

Wheeler, T. Ray — Rural spec., Missouri Power and Light Co., 106 W. High St., Jefferson City, Mo.

Witmer, Bill B. — Power use coordinator, Eastern Nebraska Public Power District. (Mail) Syracuse, Nebr.

TRANSFER OF MEMBERSHIP

Bartlett, George S. — Field mechanization engr., South African Sugar Assn., P.O. Box 507, Durban, Natal, South Africa (Affiliate to Member)

Buttfield, John K. — Production mgr., Oliver Australasia Pty. Ltd., P.O. Box 42, Rosebery, N.S.W., Australia (Associate Member to Member)

Detroy, Benjamin F. — Agr. engr., (NRBO) USDA. (Mail) Agr. Eng. Dept., University of Wisconsin, Madison, Wis. (Associate Member to Member)

Friday, W. H. — Instructor, agr. eng. dept., Purdue University, Lafayette, Ind. (Associate Member to Member)

Hahn, Charles L. — Hydraulic engr., div. of water, Ohio Dept. of Natural Resources, 1562 W. First Ave., Columbus 12, Ohio (Associate Member to Member)

Harris, Roland R. — Asst. prof., agr. eng. dept., University of Georgia, Barrow Hall, Athens, Ga. (Affiliate to Member)

Kucera, Henry L. — Asst. prof. and asst. agr. engr., agr. eng. dept., North Dakota State University, Fargo, N. D. (Associate Member to Member)

McKillop, Allan A. — Asst. prof. of agr. eng. and asst. agr. engr., University of California, Davis, Calif. (Associate Member to Member)

Mellen, John F. — Field engr., Caterpillar Americas Co. (Mail) No. 6 La Seiva Ave., Maraval, Trinidad, W. I.

Morris, Carl F. — Partner, Delta Engineering, Inc. (Mail) 1701 Northwestern Ave., West Lafayette, Ind. (Associate Member to Member)

Moysey, Eric B.—Asst. prof., agr. eng. dept., University of Saskatchewan, Sask., Canada (Associate Member to Member)

Saxena, Rajendra P. — Asst. agr. engr., State Tractor Organization, Government Agr. Workshop, Lucknow, U. P., India (Associate Member to Member)

Smith, Lloyd L.—Agr. engr., Transportation and Facilities Res. Branch, (AMS) USDA, Barrow Hall, University of Georgia, Athens, Ga. (Associate Member to Member)

Staley, Leonard M. — Asst. prof., agr. eng. dept., University of British Columbia, Vancouver, B. C., Canada (Associate Member to Member)

Zachariah, Gerald L. — Instructor, agr. eng. dept., Purdue University, Lafayette, Ind. (Associate Member to Member)

STUDENT MEMBER TRANSFERS

Bishop, Robert—(North Dakota Agricultural College) Mapleton, N. D.

Just, Clarence A. — (North Dakota Agricultural College) 1367 N. 13th St., Fargo, North Dakota

Keller, George W. — (Michigan State University) R.R. 1, Jasper, Mich.

Martin, George R. — (Michigan State University) R.R. 2, Fowler, Mich.

Meyer, Dennis — (North Dakota State University) 1341 6th Ave., S., Fargo, N. D.

Ulberg, Thore G. — (North Dakota Agricultural College 1326 12th St., N., Fargo, North Dakota

Yaeger, Earl C. — (North Dakota State University) 416 N. 2nd St., East Grand Forks, Minn.

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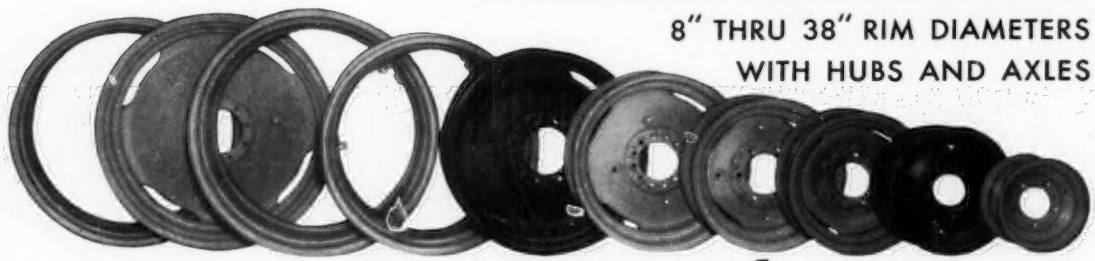
8" THRU 38" RIM DIAMETERS
WITH HUBS AND AXLES



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DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY
QUINCY, ILLINOIS

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Neither the weather-blasted, dirt-clogging grind in the fields—nor the rust-breeding periods of idleness known to every farm implement—can rob DIAMOND Roller Chain of its stamina.

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That's why, for 69 years, farm machinery builders and users alike specify DIAMOND . . . the roller chain with more manufacturing refinements to resist wear and fatigue than any other power transmission medium.

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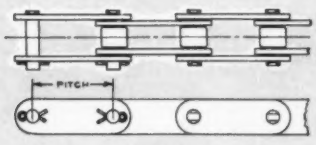

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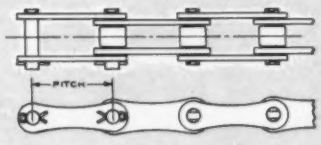
"A" Series Roller Chains

The "A" Series will connect and operate over the same sprockets as the A.S.A. 2000 Series.



DIMENSIONS

Mfgrs. Std. No.	Factory No.	Pitch	Roller Width	Roller Dia.	Pin Dia.	Side Bar Thickness	Side Bar Contour	Average Tensile Strength
CA2040	7066	1"	.312	.312	.156	.060	Oval	3700
A2040	87066	1"	.312	.312	.156	.060	Fig. 8	3700
A2050	87050	1¼"	.375	.400	.200	.080	Fig. 8	6100
CA2050	7050	1¼"	.375	.400	.200	.080	Oval	6100
A2060	87033	1½"	.500	.469	.234	.094	Fig. 8	8500
CA2060	7043	1½"	.500	.469	.234	.125	Oval	8500

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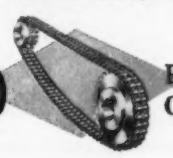


DIAMOND ROLLER CHAINS ®

PERSONNEL SERVICE BULLETIN

PERSONNEL SERVICE BULLETIN

Note: In this bulletin the following listings current and previously reported are not repeated in detail. For further information, see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this bulletin, request form for Personnel Service listing.

Positions Open—(1960) **July**—O-245-623, 256-624. **August**—O-270-625. **September**—303-627, 303-628, 303-629, 303-630, 273-631, 284-632, 309-634. **October**—O-318-636, 320-637, 322-638, 322-639, 322-640, 325-642, 326-643, 347-645. **November**—O-372-646, 392-647, 393-648. **December**—O-407-649, 425-651, 429-652, 388-653. (1961) **January**—O-434-654, 440-655, 461-656, 465-657, 465-658.

Positions Wanted—(1960)—**July**—W-221-53, 252-57, 253-58, 257-60. **August**—W-263-61, 264-62. **September**—W-274-65, 281-66, 282-67, 283-68, 294-70, 287-73, 287-73, 297-74, 300-75. **October**—W-305-76, 314-77, 323-78, 328-79. **November**—W-338-80, 377-81, 379-83, 365-84, 376-86, 355-87, 394-88. **December**—W-420-89, 419-90, 412-93. (1961) **January**—W-431-94, 444-95, 453-96, 468-97.

NEW POSITIONS OPEN

Agricultural Engineer for product research and development with established manufacturer of farm machinery, including farm materials handling equipment. Midwest. Age 25-35. BSAE or BSME. Experience 4 years in farm machine design and/or research. No physical handicaps. Supervisory ability necessary. Opportunity for advancement to chief engineer. Salary open. O-11-101

Design Engineer for pneumatic conveying systems with established growing manufacturer in upper Midwest. Responsible for design and installation of systems, selection of components, engineering advice to sales department, coordination of drafting, electrical, service, installation, and other phases of assigned jobs. Married. Age 30-45. BSAE, ME, or CE (structural). Experience 3 years in field of air conveying, including plant layout. High degree of aptitude for working with architectural blueprints. Company one of largest in its field, with 700 employees. Doubling volume each 5 years. Average age of top management, 37. Salary $8400-9000. Inquire or apply by mail only. O-13-102

Technical Service Engineer for fertilizer supplier in Southeast. Supervise installations and maintenance of company's field storage tanks for nitrogen solutions and anhydrous ammonia. Advise customers on field application equipment. Age 21-35. BSAE. Experience helpful but not required. Must be able to meet and talk easily with farmers, fertilizer dealers, and manufacturers. Opportunity for growth in responsibility with company expansion, either in sales field or increase in types of products. Excellent group insurance and retirement program. Salary $5100 plus car and expenses. O-10-103

Agricultural Engineer to head teaching program in farm power and machinery in an eastern school with ECPD accredited agricultural engineering curriculum. Opportunity for some research. Age 28-40. BSAE and MS in agricultural or mechanical engineering. Prefer man with PhD or good progress toward completing PhD requirements. Experience at least two years teaching or with farm equipment manufacturer, or combination of both. Integrity, industry, desire to work with students, and willingness to cooperate with other staff members in departmental programs. Excellent opportunity in expanding program. Opening available in September, on retirement of staff member. Excellent retirement, leave, and other fringe benefits. Salary open. O-35-104

Graduate Fellowships in cotton ginning engineering (six to be awarded in next two years) to work for MSAE with concentration on cotton ginning engineering in a southeastern state college. Age under 35. BSAE or BSME. Acceptable for admission to graduate school. Interest in cotton ginning research or education. Application deadline for 1961-62 school year is April 1. Salary $2500 for 12 month. O-36-105

Irrigation Engineer (assistant) for design, development, and field evaluation of equipment used in overhead and surface irrigation systems. Location Hawaii. BSAE or BSCE. Experience in irrigation and agricultural equipment desirable but not required. Ability to handle research projects and a limited amount of extension work. Salary open. O-57-106

NEW POSITIONS WANTED

Agricultural Engineer for sales work in power and machinery field with manufacturer or distributor. Prefer East Coast territory. Married. Age 34. No disability. BSAE, 1948, Pennsylvania State University. Farm background. Sales training, territory sales, and branch sales manager 12 years. War service in Navy 29 months. Available on reasonable notice. Salary $9000. W-8-1

Agricultural Engineer for design and development in power and machinery with manufacturer in Midwest or West. Single. Age 28. No disability. BSAE, 1960, University of Minnesota. Farm background. Experience in Navy nearly 4 years (electrician). With Remington Rand 6 months on assembly of Univac Computer. U.S. Geological survey 3 months as field assistant. Since graduation 6 months with REA Coop as power use advisor. Available March 15. Salary open. W-21-2

Agricultural Engineer for design, development, or research in farm structures or soil and water with industry or public service in Midwest, Northwest, or Canada. Moderate travel. Married. Age 34. No disability. BSAE, 1955, North Dakota Agricultural College. Farm background. Experience 2 years in soil survey; 1½ years in structural design in USA. Since Oct. 1, 1959, in Sweden, in stress analysis, hydraulic computations, and cost estimating with civil engineer on water and sewage projects. War service in Swedish army. Available in early spring. Salary $600 per month. W-22-3

Agricultural Engineer for design, development, research, or teaching in farm structures, with industry or public service, anywhere in USA. Single. Age 23. No disability. BSAE, 1959, and MSAE expected 1961, Michigan State University. Dairy farm background. Available March 1. Salary $6000-7000. W-24-4

Agricultural Engineer for development, extension, teaching, or research in product processing with industry or public service. Northeast preferred, or Midwest or West. Single. Age 25. No disability. BS in agriculture, University of Connecticut, 1958. MSAE, University of Massachusetts, 1960. Operated dairy farm 1½ years. Research Fellow one year. Instructor half time one year. Active commissioned service in Army, 6 mo. Available September 1. Salary $6000-7000. W-29-5

Agricultural Engineer for design, development, research, sales, or service in soil and water field with manufacturer, distributor, consultant, or farming operation. Prefer northern location. Married. Age 31. No disability. BSAE, 1952, University of Idaho. Farm background. Operated irrigated farm 3 years. Work unit engineer with SCS 4 years. U.S. Air Force. Commissioned active service 2 years. Reserve status, Captain. Available on 60 to 90 days notice. Salary open. W-16-6

Designer, for design, development, research, liaison, expediting, sales, or service in power and machinery or contract construction, with manufacturer or distributor. Location Mansfield, Ohio area, or possibly Wisconsin. Married. Age 43. No disability. Special study in engineering mathematics, welding, strength of materials, and other courses related to jobs held. Experience from 1937 to 1954 with farm equipment manufacturers, working up through shops to field engineer, assistant to chief engineer, and coordinator of design. Design with electrical appliance manufacturer 1954-55. Plans engineer with large contract construction firm 1955-57. Master design draftsman with manufacturer of automatic washers, 1957-58. Assistant experimental designer working with chief designer for manufacturer of seating for transportation, 1958-60. Available on reasonable notice. Salary approximately 500 per month. W-30-7

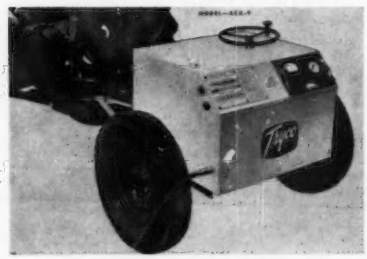
Agricultural Engineer for design, development, research, extension, or teaching in soil and water field with public service or with consultant, farming operation or trade association, anywhere in U.S. or Canada. Married. Age 36. No disability. BSAE, 1952; MSAE (with minor in CE) 1960, South Dakota State College. Farm background. SCS engineering 6 yr. Graduate assistant 2 yr. ARS, USDA, 1 yr. in field investigations for research. Military service over 1 yr. in Army. Available on reasonable notice. Salary open. W-34-8

Russian S and W Books Available for Translation

B. D. van't Woudt, assistant agricultural engineer, University of Hawaii, Honolulu, advises that he has brought back with him from a recent trip to Russia the following books and will be happy to make any of these available to institutions: The Biological Basis of Irrigation Engineering, by N. S. Petinov, 1957; The Basis of Exploitation of Irrigation and Drainage Systems, by V. A. Shaumyan, 1957; Report 31, Institute for Hydrotechnique and Amelioration, by Trudy, 1957; Vol. 28, Institute for Hydrotechnique and Amelioration, by Trudy, 1958; Hydrotechnical Information on Amelioration and Hydrotechnique, Vol. 8, 1960; Hydrotechnical Information on Amelioration and Hydrotechnique, Vol. 7, 1960.

New Shop Dynamometer

Tryco Manufacturing, 1160 South Monroe St., Decatur, Ill., has developed a dynamometer designed for shop use. The com-



pany, it is said, was interested in constructing a unit that would be priced low enough that a school would be able to purchase one for use in shop courses.

The unit's power panel is completely portable and may be mounted on the front of the dynamometer, on the tractor seat, or elsewhere for greater visibility. A dual-range power gage indicates both horsepower and torque at all speeds. The electric tachometer also performs a dual function. A switch changes the range from PTO speed of 540 rpm to 1000 rpm. Units are available in both portable and stationary models.

Pole-Top Entry Service

Hi Products, Inc., 2541 S. Louisiana Ave., St. Louis Park 26, Minn., has developed a new pole-top service entrance with a safety switch blade type disconnect. Available in six standard models, the new switch is so designed that any arcing is concentrated to an area of the switch blade outside the jaw contact, thus according to the company, eliminating poor contact due to pitted blades.

A heavy spring loaded snap action provides "quick make-quick break" service. Ground level control is available with either a straight push-pull or toggle type handle which can be locked in either "off" or "on" position. The series also includes three models of a double-pole, double-throw switch. This unit is primarily designed for use on services requiring protection from standby generators. The double-throw switch is designed to eliminate the possibility of power being fed back into distribution lines from standby units.

New Oil Filter Element

Caterpillar Tractor Co., Peoria, Ill., has announced a new lubrication oil filter element for its line of track-type and Traxcavator models and motor graders except the D9. The new element, known as 7M 3800, is a paper element which removes an even greater percentage of impurities than was possible with previous models.

The new development is said to be a definite advance in filter design, and represents two years of research and development. Construction of the filtering paper and special grooving of the filtering paper are said to be responsible for the unit's efficiency. The new element is used also in the company's torque converter, transmission, brake and steering, or crankcase lubrication systems, as well as in these component systems of the No. 583 and No. 572 pipelayer models. Additionally, it is used in the line of diesel engines except models D353, D337 and D326.

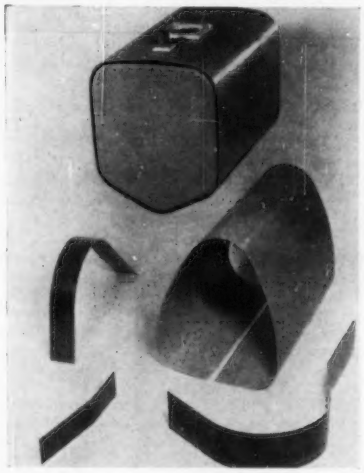
Adds to Its Steel Line

The Crucible Steel Company of America, Pittsburgh 22, Pa., has announced the availability of a low-temperature air-hardening die steel which will be marketed under the trade name Orbit. In addition to its free machining qualities, this all-around tool steel (AISI grade A-6) is said to combine many of the advantages of air-hardening grades with the low-hardening temperature of soil-hardening grades.

The manufacturer reports that addition of the new product will be of particular importance to both large and small users of tool steel.

New Fiber Glass Forming Process

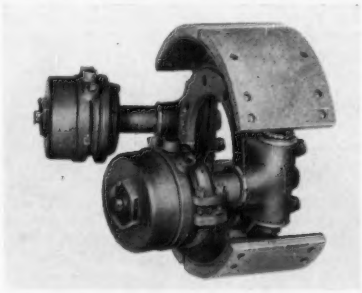
Molded Fiber Glass Sheet Co., Ashtabula, Ohio, has introduced a new process which provides increased design latitude



and economy in the manufacture of reinforced plastics for intricately contoured parts. By the new method, flat molded fiber glass panels can be formed into extreme and compound curvatures. A variety of wall thickness and any curvature down to a radius of 3 in. are said to be possible with this new process.

New Brake Design

Rockwell-Standard Corp., Brake Division, Ashtabula, Ohio, has introduced a new brake design for use in commercial ve-



hicles. Available in 15-in. diameter and 2¼ to 7-in. widths, the new brake is designed to reduce heat fade and increase drum and lining life. Larger sizes are available for special equipment, earthmoving and construction applications. By interchanging the actuator units, the new brake can be either air or hydraulically actuated. All actuating parts are enclosed and lubrication-sealed. Standardization of this brake design for both air and hydraulic installations results in a reduction in service parts inventory. Units are suited for straight air, straight hydraulic, air-over-hydraulic, or vacuum-over-hydraulic systems.

An optional feature of the new brake is a provision for normal air operation and a mechanical parking brake. Primary purpose of this feature is to prevent runaway vehicles due to loss of air, whether in operation or parked. A second optional feature is automatic adjustment, which maintains proper brake adjustment during the entire lining life.

Grain Moisture Meter

The Kel Engineering and Equipment Co., P.O. Box 744, New Brunswick, N. J., announces the introduction of a new type grain moisture meter to test the moisture content of grains within 2 to 3 min.

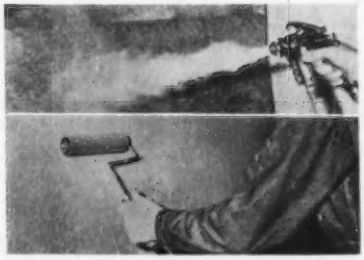
The new device is compact, light and portable and easy to operate to measure the moisture content in grains such as rice, barley, wheat, rye, soy beans, red beans, corn and maize. It can be used anywhere where a-c electric power is available.

Synthetic Mulch

The Firestone Tire & Rubber Co., 1200 Firestone Parkway, Akron 17, Ohio, has announced the use of synthetic rubber latex in a variety of bright colors as a means of preventing erosion of newly-seeded areas. The new material, called Vulcanol, has been used at various test sites as a substitute for or in conjunction with conventional hay or straw mulch. The new product is diluted with water and sprayed over bare soil. It forms a web-like coating which prevents erosion during germination of the seed. New grass grows through the porous material, which decomposes after one to six months.

Flake Coating Developed

Owens-Corning Fiberglas Corp., 717 Fifth Ave., New York, N. Y., has introduced a new spray coating for providing a corrosion-resistant surface to metals, wood and concrete. Accelerated weathering tests by the company have shown the following: Vapor transmission, less than 0.01 perms; shear strength, 800 psi; and dielectric strength, 500 volts per mil.



According to the manufacturer, the coating, a homogeneous mixture of Fiberglas flake, resin, fillers, accelerator and pigment (if desired), can be used in many applications where corrosion is a problem, such as on chemical and oil storage tanks, jackets for industrial stack insulation, industrial ducting of chemical materials, and concrete sewer lines. Other applications foreseen for the coating are as a liner for concrete industrial flooring, as a water sealant for concrete block and slab walls, as a sealant from corrosive salts and as a lining for freight and reefer railroad cars and trucks. A 20-mil thick coating of this new product, said to provide 50 layers of flake, can be obtained in one application.

. . . With ASAE Sections

(Continued from page 92)

neers, Scientists, and Architects Day on February 23. This program is sponsored by the D. C. Council of Engineering and Architectural Societies and the Washington Academy of Sciences at the Presidential Arms, Washington, D. C.

Adopts Anniversary Seal

In commemoration of its silver anniversary, the Georgia Section of ASAE adopted the following "Silver Anniversary" seal.

Forms New Agricultural Mechanization Club

An organizational meeting for a new club was held on the University of Illinois campus on November 29, 1960. The club will be known as the Illini Agricultural Mechanization Club and its objectives will be: To promote social and technical interest of students in the agricultural mechanization curriculum; to acquaint present and potential members with opportunities in the agricultural mechanization field; to obtain recognition for agricultural mechanization on campus and in industry; and to aid in development of agricultural mechanization as a definite contribution to the nation's agriculture. The following officers have been elected: James Rowley, president; Charles Mund, vice-president; David Close, secretary-treasurer; Gilbert Knap, reporter; David Clark, Agriculture Council representative; Richard Wilson and Bobby Fry, Program Committee co-chairmen; B. J. Butler, faculty advisor, and D. R. Daum, assistant faculty advisor.

. . . New Books

(Continued from page 95)

conversion, air pollution, various kinds of mechanization, frost protection, fertilizer application, pruning methods, equipment for digging postholes, transport of products in orchards, etc. One page is even devoted to the National Tillage Machinery Laboratory at Auburn, Ala. This book, written in the Dutch language, should be of value to anyone interested in keeping up with new ideas in horticulture and truck crop farming. Reviewed by Herman Bouwer, agricultural engineer, Western Soil and Water Management Research Branch, Soil and Water Conservation Research Division, ARS, USDA, Southwest Water Conservation Laboratory, Tempe, Ariz.

Proceedings of the Sprinkler Irrigation Industry Open Conference — March 1960. Paper 8½ x 14 in. 102 pages. Available from Sprinkler Irrigation Association, P.O. Box 455, Los Gatos, Calif. $3.00.

These Proceedings cover the subjects presented and the resulting discussions at the Sprinkler Irrigation Industry Open Conference, sponsored by SIA, at the LaSalle Hotel, Chicago, Ill., March 14-16, 1960. It provides a comprehensive picture of sprinkler irrigation equipment, objectives, accomplishments, and problems.

Water Facts for the Nation's Future, by Walter B. Langbein and William G. Hoyt. 288 pages. Illustrated. Published by The Ronald Press Co., 15 E. 26th St., New York 10, N. Y. $5.00.

This book analyzes basic hydrologic information in relation to power generation, irrigation, flood control, water supply, pollution control, watershed management, and project operation. Also included are suggestions for improvement in light of cost, administration, and publication needs.

California Civil Engineering Registration Examinations, by August E. Waegemann. 8½ x 11 in. 418 pages. May be secured from August E. Waegemann, 1740 Crockett Lane, Hillsborough, Calif. $7.00.

This is an enlarged and revised book covering examinations given by the state of California for the registration of civil engineers and engineers in training. The examinations given between 1940 and July of 1949 include the unofficial solutions of the problems by the author and the balance of the examinations from July of 1949 to and including June 1957 include the problems only. All options for the civil engineers' examinations are included together with the engineers in training examinations for all branches of engineering.

Salaries and Income of Engineering Teachers — 1960. Paper. 6 x 9 in. 32 pages. Available from Engineering Manpower Commission, 29 W. 39th St., New York 18, N. Y. 25 cents.

This report is the third in a series of analyses of salaries and total professional income of engineering teachers in the United States, based upon data collected by the engineering income surveys conducted every other year by the Engineering Manpower Commission of the Engineers Joint Council in cooperation with The American Society for Engineering Education. Data for this report are gathered through individual questionnaires and are based on returns from 5,225 engineering teachers. This study is principally a supplement to a more comprehensive survey of professional income of all engineers, scheduled for publication by the Commission later this year.

Report of the First International Agricultural Aviation Conference — 1959. Cloth. 6 x 9 in. 429 pages. Illustrated. Published by International Agricultural Aviation Centre, le v.d. Boschstraat 4, The Hague, Netherlands. $7.00.

This report covers such agricultural aviation aspects as: The biological basis of aerial agriculture — orchard spraying with aircraft, review of materials for aerial application, invert emulsions, the drift hazard, droplet size and recovery of sprays, spraying weeds from the air; aircraft — the operator's requirements, requirements for an agricultural helicopter, distribution equipment, the distribution of granular fertilizers from light aircraft, rotary atomizers, international airworthiness requirements for agricultural aircraft, corrosion by agricultural chemicals in airframes and equipment, economic factors affecting agricultural aircraft operations; toxicological aspects — safety precautions, techniques of low flying and flight safety, causes of accidents in agricultural aviation, meteorological aspects of agricultural aviation, ground organization, beaconing. Also included are the discussions that followed the presentation of the papers.

Water and Its Relation to Soils and Crops, reprinted from *Advances in Agronomy,* Vol. 11, and coordinated by M. B. Russell. Paper. 6 x 9 in. 131 pages. Illustrated. Academic Press Inc., 111 Fifth Ave., New York 3, N. Y. $4.00.

This review was written as part of the work of the Committee on Soil-Crop-Water Relationships, appointed early in 1957 by the Agricultural Board of the National Academy of Science — National Research Council. It is an attempt to develop an over-all picture in the soil-plant-water system. The focus of discussion is on the part of the hydrologic cycle that begins when the raindrop strikes the soil surface and ends when the water molecule returns to the atmosphere or moves out of the range of plant roots.

Construction and Maintenance for Farm and Home, by Edward W. Foss. Cloth. 6 x 9¼ in. ix+373 pages. Illustrated and indexed. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. $6.95.

This book, a guide to shop skills and materials, tells and shows how to use all types of hand and power tools to perform the usual repair and construction work of farm and home. It also presents related information concerning materials such as wood and metal, for selection of the kinds of materials or supplies required for different jobs. Also described is the difference in use and construction of the many power tools, for assistance in choosing the right tool for general or specific purposes. It is designed primarily as a text for high school vocational agriculture use, and it can also serve as a basic text for beginning technical or college farm shop courses. In addition, it is a reference for "do-it-yourselfers" and for part-time repairmen.

Water Inventory of the Maumee River Basin — Ohio. Paper, 8½ x 11 in. 112 pages. Illustrated. Available, as Report No. 11 — Ohio Water Plan Inventory, from Ohio Division of Water, 1562 W. First Ave., Columbus 12, Ohio. $3.85.

This report is a compilation of the existing information on water problems and possible solutions in the 4,856 square-mile Ohio portion of the Maumee River basin. Included is information on economic factors affecting water use. Present water demand by municipalities, industries and agriculture is also analyzed. Potential sources of water and quantities available for the future are computed, and recreation, flood control, and watershed management are also considered. It deals with 17 counties and 62 municipalities that have public water systems. Also included are 15 fold-in maps and charts.

Chemistry and Technology of Fertilizers, edited by Vincent Sauchelli. Cloth. 6 x 9 in. x+692 pages. Illustrated and indexed. Published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. $18.00.

This book is the American Chemical Society's Monograph Series No. 148 and is a survey of the chemical fertilizer industry. Raw materials used in chemical fertilizers and the conversion of these materials to suitable chemical compounds for the feeding of crop plants are discussed under the following topics: The factors controlling the preparation of conventional mixed fertilizers; the caking problem; the theory and practice of drying and cooling fertilizers; liquid fertilizers; and corrosion and methods of preventing it in the manufacturing process. This book is directed to the person or persons who are engaged or expect to be engaged in the fertilizer industry and should also be of value to chemists, chemical engineers, plant superintendents, and to management charged with the responsibility of selecting efficient and economical processes for the production of fertilizers.

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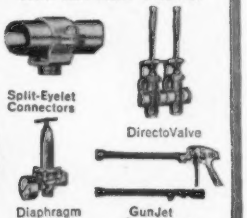

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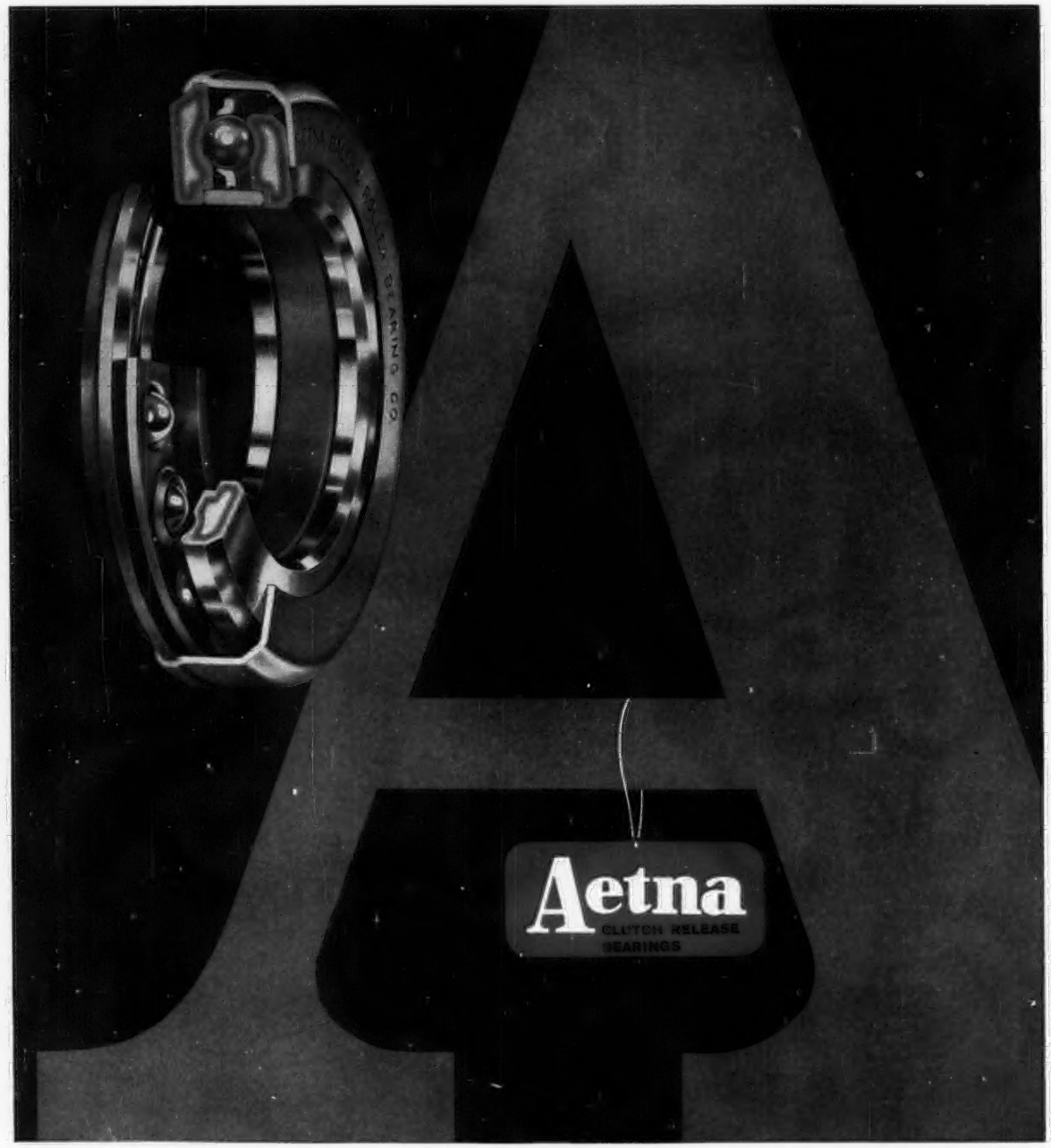

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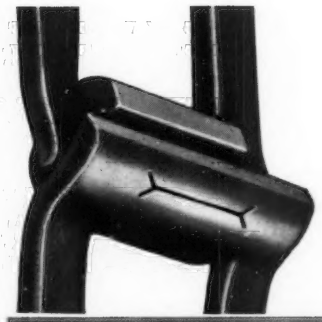

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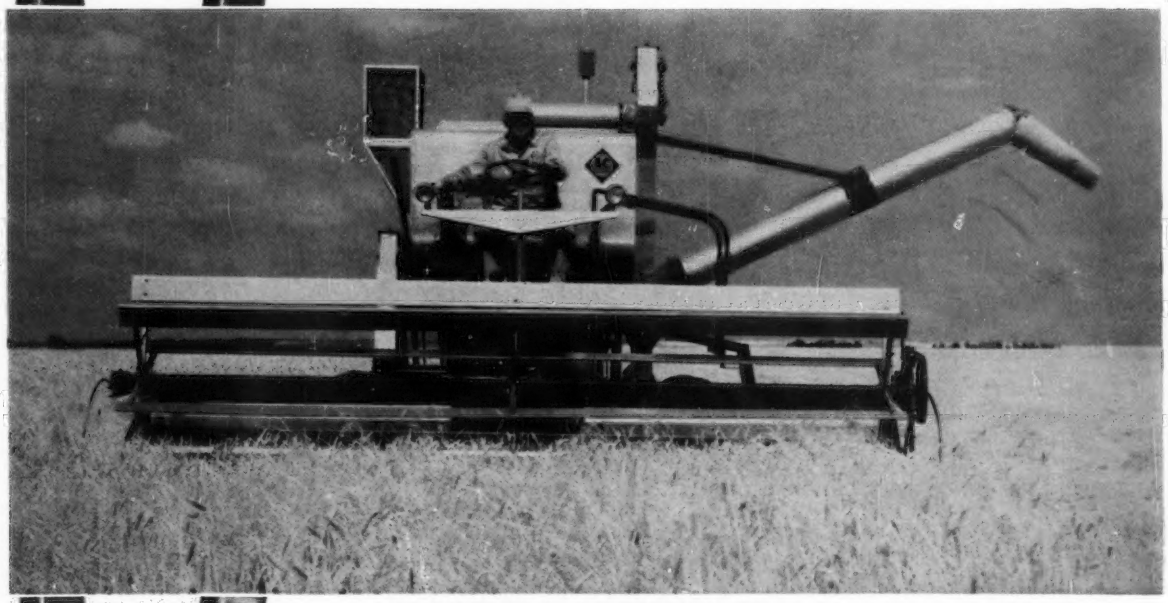

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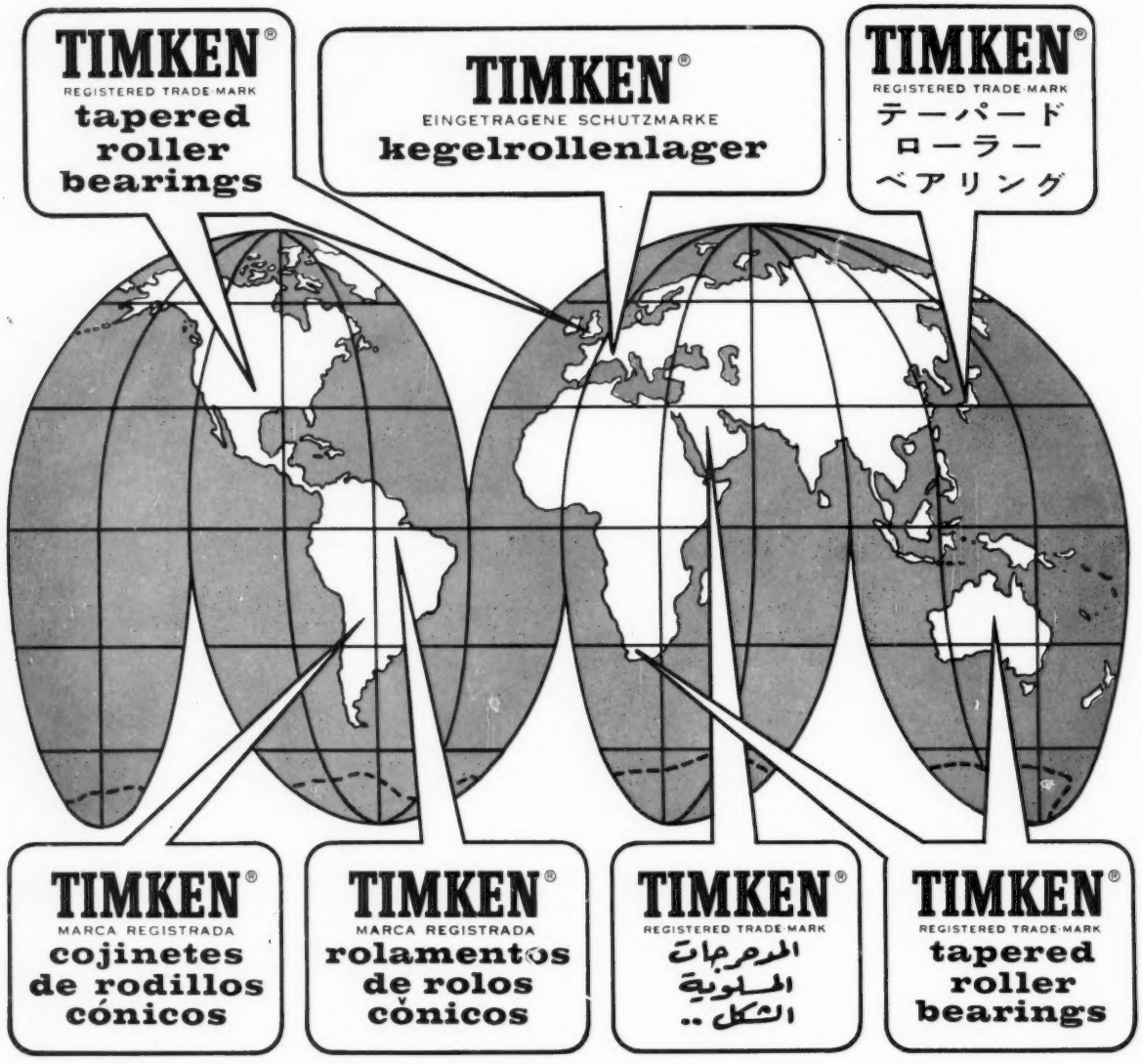

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